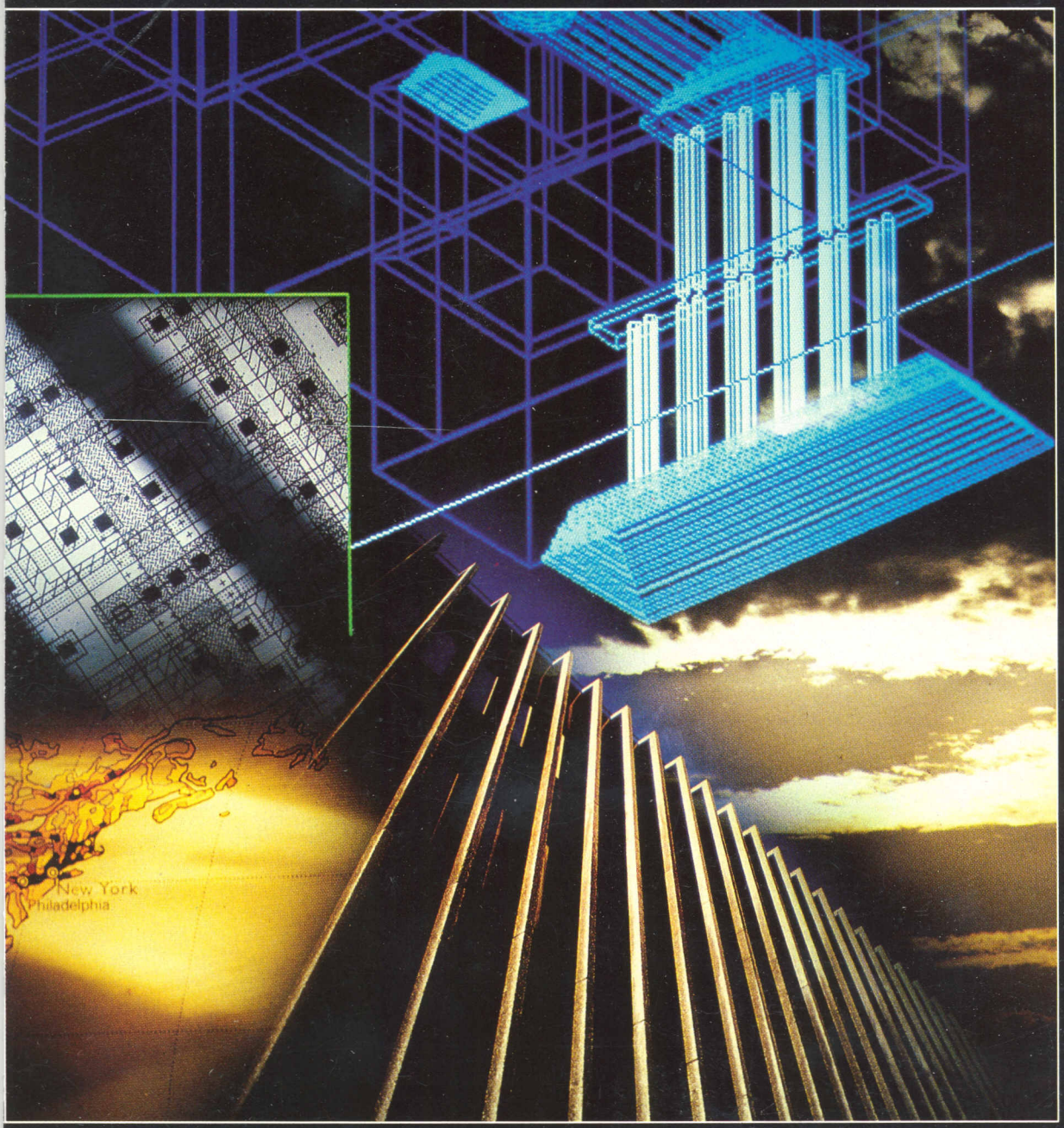
intel

Product Guide



Order Number: 210846-006

LITERATURE

To order Intel literature write or call:

Intel Literature Sales
P.O. Box 58130
Santa Clara, CA 95052-8130

Toll Free Number:
(800) 548-4725*

Use the order blank on the facing page or call our **Toll Free** Number listed above to order literature. Remember to add your local sales tax and a 10% postage charge for U.S. and Canada customers, 20% for customers outside the U.S. Prices are subject to change.

1988 HANDBOOKS

Product line handbooks contain data sheets, application notes, article reprints and other design information.

NAME	ORDER NUMBER	**PRICE IN U.S. DOLLARS
COMPLETE SET OF 8 HANDBOOKS Save $50.00 off the retail price of $175.00	**231003**	**$125.00**
AUTOMOTIVE HANDBOOK (Not included in handbook Set)	231792	**$20.00**
COMPONENTS QUALITY/RELIABILITY HANDBOOK (Available in July)	210997	**$20.00**
EMBEDDED CONTROLLER HANDBOOK (2 Volume Set)	210918	**$23.00**
MEMORY COMPONENTS HANDBOOK	210830	**$18.00**
MICROCOMMUNICATIONS HANDBOOK	231658	**$22.00**
MICROPROCESSOR AND PERIPHERAL HANDBOOK (2 Volume Set)	230843	**$25.00**
MILITARY HANDBOOK (Not included in handbook Set)	210461	**$18.00**
OEM BOARDS AND SYSTEMS HANDBOOK	280407	**$18.00**
PROGRAMMABLE LOGIC HANDBOOK	296083	**$18.00**
SYSTEMS QUALITY/RELIABILITY HANDBOOK	231762	**$20.00**
PRODUCT GUIDE Overview of Intel's complete product lines	210846	**N/C**
DEVELOPMENT TOOLS CATALOG	280199	**N/C**
INTEL PACKAGING OUTLINES AND DIMENSIONS Packaging types, number of leads, etc.	231369	**N/C**
LITERATURE PRICE LIST List of Intel Literature	210620	**N/C**

*Good in the U.S. and Canada

**These prices are for the U.S. and Canada only. In Europe and other international locations, please contact your local Intel Sales Office or Distributor for literature prices.

About Our Series of Covers:

Intel's innovative microcomputers are, in effect, "machines for living". They pervade all aspects of modern life, rolling back the limits of the possible. We have chosen to use images of the City, itself a machine for living (on quite a different scale), as our metaphor for the series.

About Our Cover:

As this guide is your point of entry into the extensive line of products offered by Intel, our cover reflects its position in the series as a portal, a roadmap, a guide.

Intel Literature update Service

Get Intel's Latest Technical Literature, Automatically!

Exclusive, Intel Literature Update Service

Take advantage of Intel's year-long, low cost Literature Update Service and you will receive your first package of information followed by automatic quarterly updates on all the latest product and service news from Intel.

Choose one or all five product categories update

Each product category update listed below covers in depth, all the latest Handbooks, Data Sheets, Application Notes, Reliability Reports, Errata Reports, Article Reprints, Promotional Offers, Brochures, Benchmark Reports, Technical Papers and much more. . .

1. Microprocessors

Product line handbooks on Microprocessors, Embedded Controllers and Component Quality/Reliability, *Plus,* the Product Guide, Literature Guide, Packaging Information and 3 quarterly updates. $70.00 Order Number: **555110**

2. Peripherals

Product line handbooks on Peripherals, Microcommunications, Embedded Controllers, and Component Quality/Reliability, *Plus,* the Product Guide, Literature Guide, Packaging Information and 3 quarterly updates. $50.00 Order Number: **555111**

3. Memories

Product line handbooks on Memory Components, Programmable Logic and Components Quality/Reliability, *Plus,* the Product Guide, Literature Guide, Packaging Information and 3 quarterly updates. $50.00 Order Number: **555112**

4. OEM Boards and Systems

Product line handbooks on OEM Boards & Systems, Systems Quality/Reliability, *Plus,* the Product Guide, Literature Guide, Packaging Information and 3 quarterly updates. $50.00 Order Number: **555113**

5. Software

Product line handbooks on Systems Quality/Reliability, Development Tools Catalog, *Plus,* the Product Guide, Literature Guide, Packaging Information and 3 quarterly updates. $35.00 Order Number: **555114**

To subscribe, rush the Literature Order Form in this handbook, or call today, toll free (800) 548-4725.*

Subscribe by March 31, 1988 and receive a valuable free gift.

The charge for this service covers our printing, postage and handling cost only.

Please note: Product manuals are not included in this offer.

Customers outside the U.S. and Canada should order directly from the U.S.

Offer expires 12/31/88.

*Good in the U.S. and Canada.

intel

intel

LITERATURE SALES ORDER FORM

NAME: _____

COMPANY: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

COUNTRY: _____

PHONE NO.: ( ) _____

ORDER NO.	TITLE	QTY.	PRICE	TOTAL

Subtotal _____

Must Add Your Local Sales Tax _____

Must add appropriate postage to subtotal (10% U.S. and Canada, 20% all other) → Postage _____

Total _____

Pay by Visa, MasterCard, American Express, Check, Money Order, or company purchase order payable to Intel Literature Sales. Allow 2-4 weeks for delivery.

☐ Visa ☐ MasterCard ☐ American Express Expiration Date _____

Account No. _____

Signature: _____

Mail To: Intel Literature Sales
P.O. Box 58130
Santa Clara, CA
95052-8130

International Customers outside the U.S. and Canada should contact their local Intel Sales Office or Distributor listed in the back of most Intel literature.

European Literature Order Form in back of book.

Call Toll Free: (800) 548-4725 for phone orders

Prices good until 12/31/88.

Source HB

Intel the Microcomputer Company:

When Intel invented the microprocessor in 1971, it created the era of microcomputers. Whether used as microcontrollers in automobiles or microwave ovens, or as personal computers or supercomputers, Intel's microcomputers have always offered leading-edge technology. In the second half of the 1980s, Intel architectures have held at least a 75% market share of microprocessors at 16 bits and above. Intel continues to strive for the highest standards in memory, microcomputer components, modules, and systems to give its customers the best possible competitive advantages.

PRODUCT GUIDE

1988

intel®

Intel Corporation makes no warranty for the use of its products and assumes no responsibility for any errors which may appear in this document nor does it make a commitment to update the information contained herein.

Intel retains the right to make changes to these specifications at any time, without notice.

Contact your local sales office to obtain the latest specifications before placing your order.

The following are trademarks of Intel Corporation and may only be used to identify Intel Products:

Above, BITBUS, COMMputer, CREDIT, Data Pipeline, FASTPATH, Genius, i, i², ICE, iCEL, iCS, iDBP, iDIS, I²ICE, iLBX, i_m, iMDDX, iMMX, Inboard, Insite, Intel, int$_e$l, int$_e$lBOS, Intel Certified, Intelevision, int$_e$ligent Identifier, int$_e$ligent Programming, Intellec, Intellink, iOSP, iPDS, iPSC, iRMK, iRMX, iSBC, iSBX, iSDM, iSXM, KEPROM, Library Manager, MAPNET, MCS, Megachassis, MICROMAINFRAME, MULTIBUS, MULTICHANNEL, MULTIMODULE, MultiSERVER, ONCE, OpenNET, OTP, PC BUBBLE, Plug-A-Bubble, PROMPT, Promware, QUEST, QueX, Quick-Pulse Programming, Ripplemode, RMX/80, RUPI, Seamless, SLD, SugarCube, SupportNET, UPI, and VLSiCEL, and the combination of ICE, iCS, iRMX, iSBC, iSBX, iSXM, MCS, or UPI and a numerical suffix, 4-SITE.

MDS is an ordering code only and is not used as a product name or trademark. MDS® is a registered trademark of Mohawk Data Sciences Corporation.

*MULTIBUS is a patented Intel bus.

UNIX and StarLAN are trademarks of AT&T.
XENIX, MS-DOS, and MS-NET are trademarks of Microsoft Corp.
CP/M is a trademark of Digital Research, Inc.
PC-CAPs is a trademark of P-CAD.
DASH-4 is a trademark of FutureNet.
Deskpro 286 is a trademark of Compaq Computer Corp.
Tandy 3000 is a trademark of Tandy Corp.
IBM PC Network, PC AT, PC XT, and PC-DOS are trademarks of International Business Machines Corp.
MAP is a trademark of General Motors.
Concurrent Common LISP is a trademark of Gold Hill Computers, Inc.
DECnet and MicroVAX are trademarks of Digital Equipment Corp.
VAX is a registered trademark of Digital Equipment Corp.
VAST is a trademark of Pacific Sierra Research.

Additional copies of this manual or other Intel literature may be obtained from:

Intel Corporation
Literature Distribution
Mail Stop SC6-59
3065 Bowers Avenue
Santa Clara, CA 95051

CG-5/26/87

intel®

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Alphanumeric Index

This is not an all-inclusive part number listing to all Intel products but merely an index of those products mentioned in this Guide. Dash numbers, automotive, military and EXPRESS parts are not designated separately but are included under the generic product number.

Alphanumeric Index (Continued)

Alphanumeric Index (Continued)

Alphanumeric Index (Continued)

PRODUCT IDENTIFICATION CODES

Semiconductor components are identified as follows:

Four or five characters for device types

Up to three character modifier for power, speed, processing, etc.

Package Type

A — Hermetic, Pin Grid Array
C — Hermetic, Type C (Ceramic) Dip
D — Hermetic, Type D (Cerdip) Dip
F — Hermetic, Flatpack
N — Plastic, Leaded Chip Carrier
P — Plastic Dip and Plastic Flatpack
Q — Hermetic, Quad Flatpack
R — Hermetic, Leadless Chip Carrier
X — Unpackaged Device

A — Indicates automotive operating temperature range

I — Indicates industrial grade

J — Indicates a JAN qualified device, but is for internal identification purposes only. All JAN devices must be ordered by M38510 part number. (Example: M38510/42001 BQB), and will be marked in accordance with MIL-M-38510 specifications.

L — Indicates extended operating temperature range (−40°C to +85°C) express product with 160 ±8 hrs. dynamic burn-in.

M — Indicates military operating temperature range

Q — Indicates commercial temperature range (0°C to +70°C) express product with 160 ±8 hrs. dynamic burn-in.

T — Indicates extended temperature range (−40°C to +85°C) express product without burn-in.

Examples:

D2147H-1	High speed 4096 x 1-bit static RAM (35 ns, 180/30 mA), hermetic package type D.
C8080A2	8080A microprocessor with 1.5s cycle time, hermetic package type C, commercial temperature range.
MD8080A/B	8080A microprocessor, hermetic package type D, military temperature range, MIL-STD-883C level B processing.*

*On military temperature devices, B suffix indicates MIL-STD-883C level B processing.

INTRODUCTION

Intel introduced the first microprocessor in 1971. Today, microprocessors touch all our lives from factories to fields, from our offices to our homes. The microelectronic revolution brought greater productivity to industry, while it spawned new markets and businesses and contributed to higher quality products and a better life. As we approach the 1990's, microprocessors continue to trigger a worldwide information revolution. Personal computers, communications networks, and advances in software are providing the productivity tools necessary in today's complex office and industrial environments.

We manufacture microprocessors, microcontrollers, communication components, memory components, boards, software, and integrated systems products. All these products are based on "Open Standards" and "Open Systems" that allow you to use our components, boards, software, or systems to meet your needs quickly and produce reliable products for your market. This Product Guide summarizes Intel's offering of advanced VLSI products and services. If you are looking for something but don't see it in this guide or have a question on something that is in the guide, please contact your nearest Intel sales office.

How to Use This Guide

Intel offers this Product Guide as a ready reference tool to make it easy for you to select the set of products you'll need to meet your design objectives. You won't find every performance parameter for every device here, but you will find key features, and more importantly, cross references to products required for "total solution" designs. Products are arranged in family groups and are shown in tabular form so you can find what you need fast. An Alphanumeric Index is located on Page x to point you directly to the page where each product is listed. In the Product Highlights, we've provided a few examples of how particular designs can be executed using Intel products. Military and EXPRESS program (extended reliability) components are recapped in special sections. Customer Support Services are also contained in the guide, and include Customer Training, Consulting, and Software and Hardware Support.

Where to Find More Information

For complete product line data sheets, application notes, etc., refer to the appropriate Intel handbooks listed on the inside front cover of the guide or consult the Intel Literature Guide. For additional assistance, call your local Intel Sales Office or distributor, listed in the last section of this guide.

CUSTOMER SUPPORT

Customer Support is Intel's complete support service, which provides Intel customers with hardware support, software support, customer training, consulting services and network management services. For further information contact your local Sales Office.

After a customer purchases any system hardware or software product, service and support become major factors in determining whether that product will continue to meet a customer's expectations. Such support requires an international support organization and a breadth of programs to meet a variety of customer needs. As you might expect, Intel's customer support is quite extensive. It includes factory repair services and worldwide field service offices providing hardware repair services, software support services, customer training classes, and consulting services.

HARDWARE SUPPORT SERVICES

Intel is committed to providing an international service support package through a wide variety of service offerings available from Intel Hardware Support. See Table 1 for list of services.

SOFTWARE SUPPORT SERVICES

Intel's software support consists of two levels of contracts. Standard support includes TIPS (Technical Information Phone Service) and updates and subscription service (product-specific troubleshooting guides, and ; COMMENTS Magazine). Basic support includes updates and the subscription service. Contracts are sold in environments which represent product groupings (e.g., iRMX® environment). Contact your local sales office for a complete list of offerings.

SYSTEMS ENGINEERING SERVICES

Intel provides field systems engineering services for any phase of your development or support effort. You can use our systems engineers in a variety of ways ranging from assistance in using a new product, developing an application, personalizing training, and customizing or tailoring an Intel product to providing technical and management consulting. Systems Engineers are well versed in technical areas such as microcommunications, real-time applications, embedded microcontrollers, and network services. You know your application needs; we know our products. Working together we can help you get a successful product to market in the shortest possible time.

CUSTOMER TRAINING

Intel offers a wide range of instructional programs covering various aspects of system design and implementation. In one to ten days, a limited number of individuals learn more in a single workshop than in weeks of self-study. For optimum convenience, workshops are scheduled regularly at Training Centers worldwide. We can also take our workshops to you for

on-site instruction. Covering a wide variety of topics, Intel's major course categories include: 80386, 80286, or 8086 microprocessor/microcontroller architecture and assembly language workshops; operating systems, programming office automation, and networking workshops.

OEM, VAR, AND VEU SUPPORT SERVICES

Our goal is to make your development easier and as productive as possible. Our support services are tailored to your specific needs, whether they occur in the project start-up, development, or product introduction phase. The range of Intel support includes: on-site assistance from systems engineers for full-time project consulting, current software information with monthly bulletins and updates, preventive maintenance to keep important development equipment at its peak, and access to product specialists and technical training for your personnel. Through our Open Systems Support, we will also work with you to plan for your end-user support requirements by providing support for your entire system, not just the Intel portion—enhancing the marketability of your product.

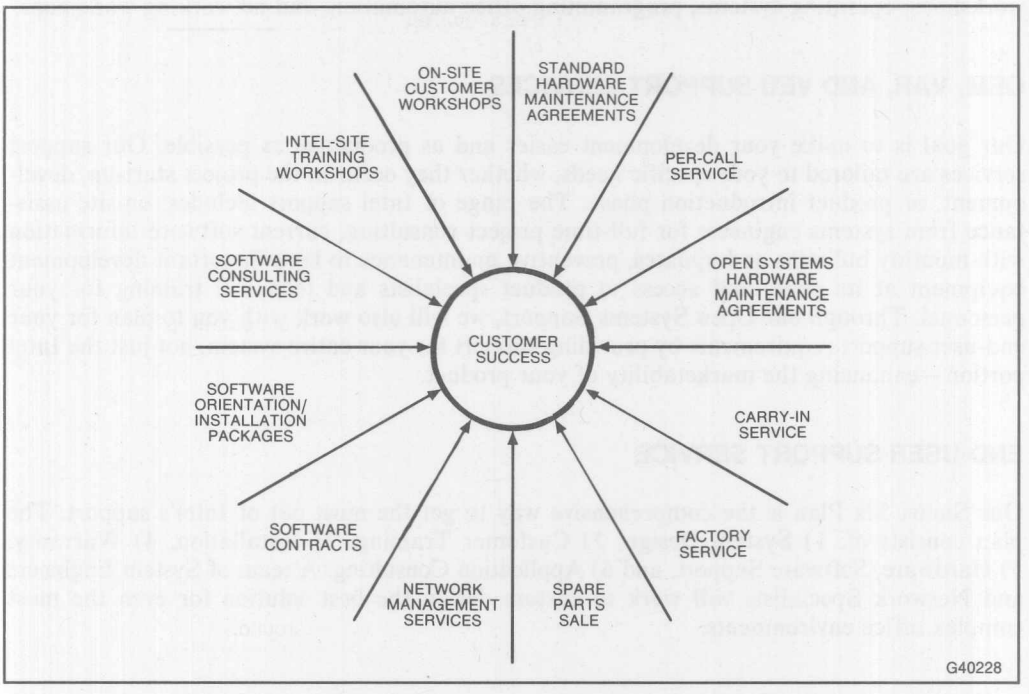
END-USER SUPPORT SERVICE

Our Smart Six Plan is the comprehensive way to get the most out of Intel's support. The plan consists of: 1) System Design, 2) Customer Training, 3) Installation, 4) Warranty, 5) Hardware/Software Support, and 6) Application Consulting. A team of System Engineers and Network Specialists will work to custom design the best solution for even the most complex office environments.

NETWORK MANAGEMENT SERVICES

Intel offers a full set of services to provide you with a single point of responsibility for all of your network needs. This includes consultation for the physical and logical network design; network installation; administrator and end-user training; worldwide service and support for multi-vendor hardware and software, software updates and the latest advances in diagnostic tools.

FULL RANGE OF SUPPORT SERVICES



1-800-INTEL 4 U
(1-800-468-3548)

Our one nationwide 800 number accommodates all your support needs using centralized dispatch. Our one call/one number system will get you to the support group you need: hardware, software, SBC repair, billing inquiries, or registration. Step-by-step instructions are provided when the 800 number is called.

Table 1. Hardware Support Offerings

Service	Highlights
Standard Hardware Maintenance Agreement	• Full-level service covering parts, labor, preventive maintenance, and engineering change installations at the customer site. • Customer selects hours of coverage. • Applies to standard Intel products.
Open Systems Support	• Provides the international service capabilities of Intel's Hardware Support organization to the end-user customer of systems integrators and OEMs. • Individually tailored contracts to meet unique equipment configurations and customer support needs. • Usually includes support for non-Intel products as part of the total support agreement.
Carry-In Maintenance Agreement	• Economical. • Same services as standard contract, but the customer delivers the equipment to an Intel facility.
Per Call Services	• Purchase labor and materials on an as-needed basis for installations, repairs, preventive maintenance, and other services.
Factory Services Factory Direct Return Authorization Service (DRA) Factory Return Replacement Authorization Service (RRA)	• Economical 30-day turnaround. • Applies to board-level products in all areas and system customers in non-serviceable areas. • Expedited service 48-hour turnaround. • Applies to currently manufactured board-level products in minimal quantities.
Installation Warranty	• Included on many Intel system products. Customer Engineer installs, services, and verifies correct operation before turning the system over to the customer. • Provided either via factory returns or at the customer site, depending on the warranty associated with that particular product.

Not all services provided for all product lines. Contact your local Intel Service Office for more specific information on the right service to meet your needs.

CUSTOMER TRAINING WORKSHOPS

MICROPROCESSORS AND MICROCONTROLLERS:
Introduction to Microprocessors
80386 ASM for 8086 Programmers
80386 Programming Using ASM 386
80386 System Software
80386 Hardware Design
ICE™-386
8086 & 80286 Real Mode Programming
80186 Microprocessors
Intel Numeric Coprocessors
Operating System Concepts using the 80286
MCS®-51 Microcontrollers
MCS-96 16-Bit Microcontrollers
BITBUS™
I²ICE™ User's Workshop
MCS-8085 Microprocessors

SELF-STUDY INSTRUCTION
Introduction to Microprocessors (Audio)

OPERATING SYSTEMS AND PROGRAMMING WORKSHOPS:
MULTIBUS® II
PL/M Programming
PL/M-86/286/386 Programming
iRMX-86 Operating System I
iRMX-86 Operating System II
iRMX-86/286 BIOS and Device Drivers
iRMX-86/286 EIOS and Human Interface
iRMX-286 Operating System
iRMX-386 Operating System
Fundamentals of XENIX
XENIX Shell Programming
XENIX System Administration
Introduction to C Programming
System Programming in "C" for XENIX
LAN Overview
iNA 960
PC Interface
EPLD
ISDN

OFFICE AUTOMATION WORKSHOPS:
Office Automation Introduction
Office Automation Advanced
Office Automation Word Processing
Office Automation Databases
iDIS™ System Administration
XENIX System Administration Part 1
XENIX System Administration Part 2
iDIS™ Network Administration
XENIX Network Administration

SELF-STUDY INSTRUCTION
Getting Started with iDIS (Video)
Key Operator Training (Video)

COMPONENT QUALITY AND RELIABILITY (Q&R)

INTEL CORPORATE QUALITY POLICY AND CULTURE

It is the policy of Intel Corporation to design, manufacture, and deliver products that satisfy all our customers' expectations and perform reliably in their applications.

Since the inception of the company, Intel has been recognized as an innovator and a leader in product quality & reliability—from silicon solutions to system products. This leadership was not achieved by accident. It resulted from a combination of clearly defined objectives, careful planning, and thorough execution. At Intel, quality is a commitment, a philosophy, and a goal: a commitment to satisfy our customers' needs; a philosophy practiced as "do it right the first time," based on personal recognition that the responsibility for quality rests on each individual; and a goal of excellence in the world marketplace.

ORGANIZATION: AN EFFECTIVE QUALITY MATRIX

All Q&R organizations adhere to a uniform policy, while still maintaining the flexibility to service the specific needs of each product area. To allow them to perform in this manner, a unique matrix organization has been developed. All Quality & Reliability functions report directly through Operations or Site Q&R Managers to the Director of Q&R for major policy and procedural matters. Flexibility is obtained by the Site/Operation QA Managers also reporting, in a matrix, to the Operation or Division General Managers for all matters related to production and products.

Additionally, each product group has a Q&R organization under a single manager. This involvement on product-specific levels provides the customer and Intel with the timely response needed to maintain a product that meets all customer expectations and totally complies with internal and external specifications. Should a problem arise, it is handled quickly and effectively at local levels and elevated, if need be, to the rest of the organization. This results in a "team" approach among quality, reliability, design engineering, manufacturing, and procurement groups—making state-of-the-art technology available in usable form to our customers.

COMPONENTS QUALITY AND RELIABILITY ORGANIZATION

Consistent with Intel's Corporate Quality Policy and Culture, the Components Quality and Reliability Organization has the following charter:

> To lead Intel in the development and *use* of techniques, systems, and tools that provide Intel and its customers with a continuously improving, competitive advantage in quality and reliability.

The principle directions being taken to meet that charter are:

To continuously strengthen our quality systems.

To provide to customers support that meets or exceeds their expectations.

To assure continually improving quality and reliability of our products and of the manufacturing technologies and processes that produce them.

The Component Quality and Reliability is organized to fully support these major thrusts.

MANUFACTURING QUALITY AND RELIABILITY

The Manufacturing Quality and Reliability organization consists of five major groups that are responsible for the development, qualification, and continual improvement of the quality and reliability of Intel's processes and packages.

1. **Process Reliability**—responsible for doing fundamental reliability studies on Intel's Fab processes and defining the design and process parameters under which reliability of the products can be assured.
2. **Package Reliablity**—responsible for doing fundamental reliability studies on Intel's assembly processes. Additionally, this group qualifies and monitors all assembly processes, assembly plants, and package types.
3. **Production Plant Quality and Reliability**—groups reside in each plant and are responsible for assuring that quality and reliability goals consistent with customer needs are met.
4. **Reliability Monitor System**—responsible for defining and maintaining a reliability monitor system which provides the data for determining that quality and reliability expectations are being met.
5. **Materials Quality Control**—responsible for ensuring that all piece parts and raw materials meet Intel's needs for the production of reliable quality components. MQC engineers develop inspection procedures for masks, chemicals, gases, and package components, and work with our vendors to help them solve their quality problems.

PRODUCT QUALITY AND RELIABILITY

The Product Quality and Reliability organizations are responsible for assuring that all Intel components meet our requirements and customers' expectations for quality and reliability. To achieve this goal, design methodologies are established to assure all process design rules and testability goals are met during the design process. In addition, product qualification methods are established to assure that products meet reliability goals. Finally, manufacturing check points are established to assure that all products shipped meet customers' expectations.

CUSTOMER QUALITY AND RELIABILITY

The Customer Quality and Reliability organization is responsible for understanding and communicating our customers' expectations and for defining actions that assure that they are met. To achieve these goals, Customer Quality and Reliability has created regional

Customer Quality Support Centers, which provide direct customer interface for communicating and resolving customer issues and problems. Customer Quality Reliability also assures that an appropriate quality system exists throughout the company to meet these goals.

COMPONENT QUALITY PROGRAMS

Component Qualification

The key to establishing a new product, process, or package, or to changing an existing one, is meeting Intel's rigid qualification requirements. Qualification must be run and approved by the appropriate reliability department before any revenue shipment can be made. The reliability goals that have been set during the concept stage must be demonstrated by the qualification. For example, during the qualification of a new wafer Fab technology for one-time programmable EPROMs, the first five wafer lots face the following tests:

125°C burn-in	168 hours
125°C lifetest	2,000 hours
150°C HTRB	1,000 hours
Low-temperature lifetest	1,000 hours
250°C storage	1,000 hours
85°C/85% RH	1,000 hours
Steam	168 hours
Temperature cycle	−55°C to +125°C
Thermal shock	−55°C to +125°C
Test pattern study	
Program/erase cycling	
System verification	

The sequence of tests determines infant mortality, random failure rates, and associated mechanisms. This data also becomes the basis of reliability reports made available to our customers.

Component Reliability Monitoring

While successful completion of qualification is the key to product introduction, it would be meaningless if the device were not sampled throughout its product life. On a rotating product basis, 125°C dynamic burn-in and lifetests are performed continuously to monitor all technologies. Fifty thousand devices each month are allocated for the Reliability Monitor Program by the Components Division. In this manner, all generic technology families are continuously scrutinized to ensure that reliability goals are met.

In the same manner, Intel Package Reliability performs an extensive package monitor program to ensure the mechanical integrity of every package type produced by every assembly facility.

FA/CR's (Failure Analysis/Correlation Request)

The need for an Intel-customer correlation effort has grown with device complexity. In response to this need, an FACR (Failure Analysis Correlation Request) system has been

established within each division or operation. Operating through the Field Sales Engineers, the program is designed to eliminate electrical test discrepancies between Intel and its customers in a timely manner. The system provides direct contact with a product-oriented Quality Engineer to eliminate test program or equipment discrepancies between the customer and Intel without returning all products shipped. The success of the program may be measured by the number of lots shipped to customers that have been questioned and accepted utilizing the FACR system. The obvious by-product of this system is to build customer confidence to the point where Intel's final test and FQA data becomes the customer's incoming inspection data.

Military Quality Assurance

The Military Quality Assurance program, operated out of Intel's Phoenix site, attends to customers within the aerospace or military industries or, in some cases, to customers who have special documentation requirements. To perform in this product area, MQA acts as an overlay on all sites and operations, defining the QA program requirements in that particular area. The success of this program may be gauged by the acceptance of selected high-technology products by the federal government and the product processing areas certified by an agency of the federal government. This department also performs process audits of applicable Intel manufacturing facilities on a regular basis to ensure compliance to rigid military traceability and process requirements.

EXPRESS PROGRAM

One other program that is offered is the EXPRESS (Extended Reliability) Program which allows users of Intel IC components to tailor the products' electrical test flow to their specific application requirements. The test flows are designed to suit a broad range of system and production requirements. See EXPRESS section for more information.

SYSTEMS GROUP QUALITY AND RELIABILITY (SQR)

ORGANIZATION

The Systems Group Quality and Reliability organization consists of a central policy and standards group, supported by a manufacturing site process and product audit group. SQR activities are in accordance with current internationally recognized standards for quality programs and are specifically organized to support ANSI 1.8 and Z 1.15 standards. SQR is an integral part of all phases of a product's life cycle. SQR reviews internal practices and organizations to assure control and provides training in the Quality Sciences as a foundation to ensure continuous quality improvement.

1. **Systems Reliability Engineering (SRE)**—administers the reliability program, develops new methods for predicting and demonstrating product reliability, and performs fundamental product reliability research. Also manages the Systems Group environmental lab, which standardizes product evaluations for vibration, shock, temperature, humidity, and reliability demonstration testing. Provides new technology qualification, such as Surface Mount Technology qualification. Develops new reliability enhancement technologies, such as Environmental Stress Screening.
2. **Systems Quality Engineering (SQE)**—manages the overall quality program for procured items as a member of Intel's Materials Commodity Management Team. Performs supplier survey, selection, and qualification activities. Monitors supplier's process and Intel's factory yield of commodities to focus on continuous quality improvement. Certifies suppliers who demonstrate process control to enter our Dock-to-Stock Preferred Vendor Program.
3. **Customer Quality Engineering (CQE)**—works with customers on all quality-related matters. Using customer inputs, produces monthly management reports with indicators of product performance in the field. Responsible for the resolution of quality problems through accountable Intel organizations to assure solution and non recurrence of the customer problems.
4. **Manufacturing Site QA (MQA)**—performs process and product audits to monitor production quality and to focus corrective actions to assure continuous quality improvement. MQA assures uniform technical standards and policies.
5. **Strategic Programs and Technologies**—provides long-term quality improvement programs that integrate quality technologies and processes in design, manufacturing, and administrative operations. Key programs such as statistical process control (SPC) are organized, taught, and implemented. Integrated information management computer programs and data analysis techniques are developed and implemented.
6. **Corporate Components Engineering (CCE)**—responsible for the selection, qualification, and control of all commercial electronic parts used in the designs of system products. Provides engineering analysis of components and Intel applications to ensure their proper specification in designs. CCE assures uniform technical standards and policies and reports administratively to Design Engineering.
7. **Product Safety Engineering (PSE)**—responsible for the evaluation and acceptance of all designs for product risk analysis and regulatory agency compliance, such as UL, CSA, VDE, IEC, and FCC compliance. Manages field product-safety programs.

8. **Peripherals and Power Supply Engineering (PPSE)**—responsible for the selection and qualification of data-storage peripheral devices and power supplies used in Intel systems products. PPSE engineers provide quality engineering support for device, level characterization, reliability, and application. PPSE engineers are also members of Intel's Commodity Management teams, to promote ongoing supplier improvement.

PRODUCT QUALITY

Assuring product quality and reliability is a complex task requiring a high degree of integration, organizational involvement, and use of specialized disciplines, notably:

— Design Control through parts selection and application, design rules, circuit analyses, derating requirements, and environmental and reliability qualification testing. Reliability Engineering is part of the product development team, and thus influences the design from the start.

— Procured Material Control through a rigorous supplier selection, qualification, and monitoring process. Our computerized supplier-control system automatically ensures procurement only from selected, qualified, and approved sources. A supplier must earn the privilege of being on our approved list. (Being included in our Dock-to-Stock program provides significant benefits to both the supplier and Intel.)

— Product Quality Monitoring and control through our automated reporting and analysis systems. Our systems provide information to the Quality and Manufacturing engineers for early adverse trend detection. It also allows for product and process improvement through a corrective action system. The final measure of our outgoing product quality is the continuous product sampling program, where the finished product is subjected to a "customer audit." Only products which meet the required quality levels are shipped.

— Customer Quality Engineering reporting systems complete the cycle. These systems provide timely field feedback and give us the ability to rapidly improve the product design and manufacturing processes.

Our approach to quality is based on a very fundamental policy: "Do it right the first time." This will allow us to achieve Intel's corporate objective of being "the customer's vendor of choice."

Further details about the Intel Systems Group Quality and Reliability program appear in our Systems Quality/Reliability Handbook and in our Reliability Reports. These can be obtained from your distributor or Intel Salesperson.

MICROPROCESSORS

The Intel 86 Architectural Family starts with the standard 8/16-Bit 8088/80C88, and the highly integrated 80188 microprocessors. Our 16-bit microprocessor line consists of the industry standard 8086/80C86; the cost-effective, highly integrated 80186; and the powerful 80286 microprocessor, with advanced multi-tasking and memory management capabilities. Our newest addition, the 80386 32-bit high-performance CHMOS microprocessor, offers such capabilities as demand paging, on-chip MMU, and multitasking support.

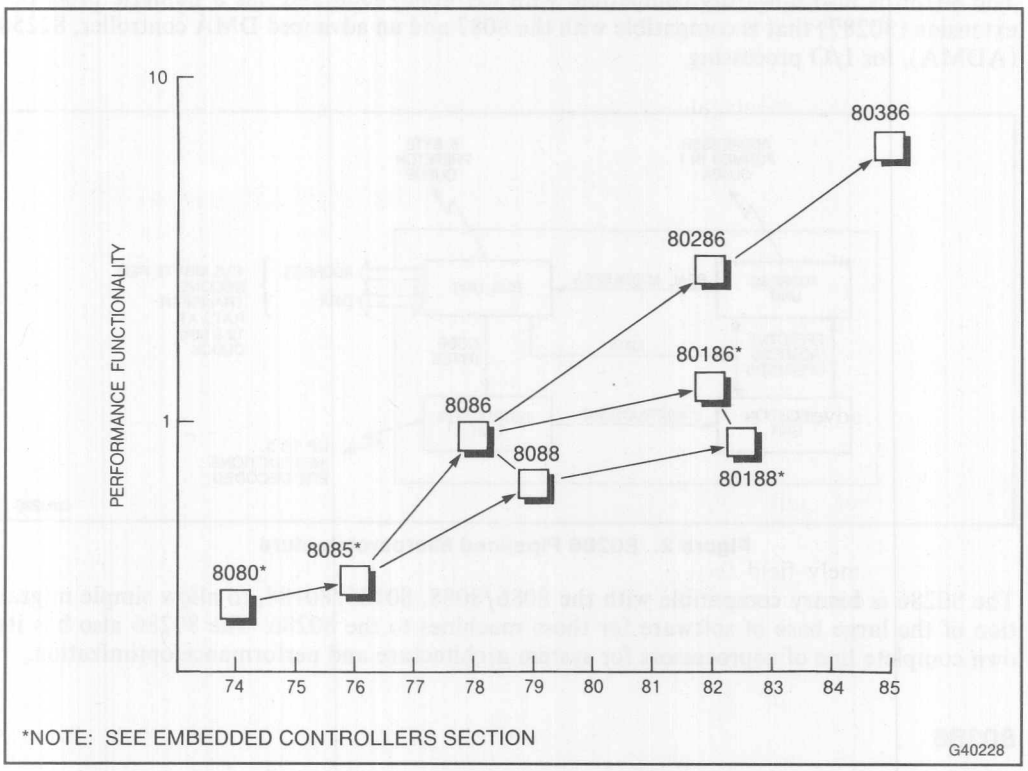


Figure 1. Microprocessor Families

8086/8088 (CHMOS AND HMOS)

The 8086/8088 includes the 8086/80C86 (16-bit bus) and the 8088/80C88 (8-bit bus) CPUs, plus a complete set of supporting devices. Because the 8086 and the 8088 share the same 16-bit internal architecture, they are completely software compatible and can use the same support components. This allows complete and full migration of software from 8- to 16-bit and 16- to 8-bit systems. The 8086/8088 have achieved industry standard status with an eight-year track record of production and availability and numerous second sources. This family is fully compatible with Intel's complete line of coprocessors, a unique set of VLSI devices that allow system-level architecture and performance customization. The 8086/8088 is available in low-power CHMOS process (80C86/80C88).

80286

The 80286 CPU is an advanced, high-performance 16-bit microprocessor with on-chip memory management and protection and hardware support for multiuser, multitasking systems. The pipelined architecture of the 80286, an 12.5 Mb/sec bus and a 2.3 μs interrupt response time, at a clock frequency of 12.5 MHz, gives it nine times the performance of a standard 5 MHz 8086. The on-chip memory management and protection scheme is flexible, sophisticated, and easy to use. It supports virtual memory of up to 1000M bytes per user. The four-level protection model provides task/task and user/operating system protection. The 80286 is also upwardly compatible with the 8086/8088 and has a numeric processor extension (80287) that is compatible with the 8087 and an advanced DMA controller, 82258 (ADMA), for I/O processing.

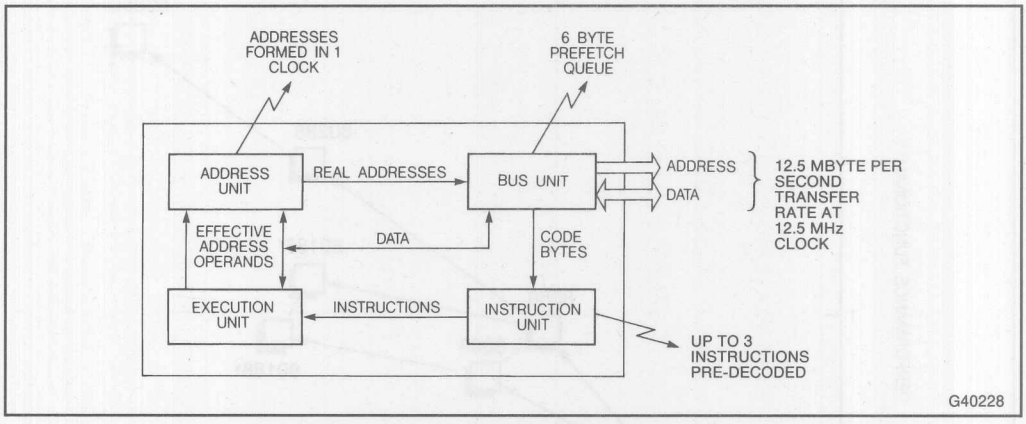


Figure 2. 80286 Pipelined Microarchitecture

The 80286 is binary compatible with the 8086/8088, 80186/80188, to allow simple migration of the large base of software for those machines to the 80286. The 80286 also has its own complete line of coprocessors for system architecture and performance optimization.

80386

The 80386 is an advanced 32-bit microprocessor designed for applications needing very high performance and optimized for multitasking operating systems. The 32-bit registers and data paths support 32-bit addresses and data types. The processor addresses up to four gigabytes of physical memory and 64 terabytes (2^{46}) of virtual memory, based on demand paging, segmentation, or both. The integrated memory management and protection architecture includes address-translation registers, advanced multitasking hardware, and a protection mechanism to support operating systems. In addition, the 80386 allows the simultaneous running of applications from multiple operating systems.

Instruction pipelining, on-chip address translation, and a high bus bandwidth ensure short average instruction execution times and high system throughput. The 80386 processor is capable of execution at a sustained rate of 4 million instructions per second at 16 MHz, with higher speeds available.

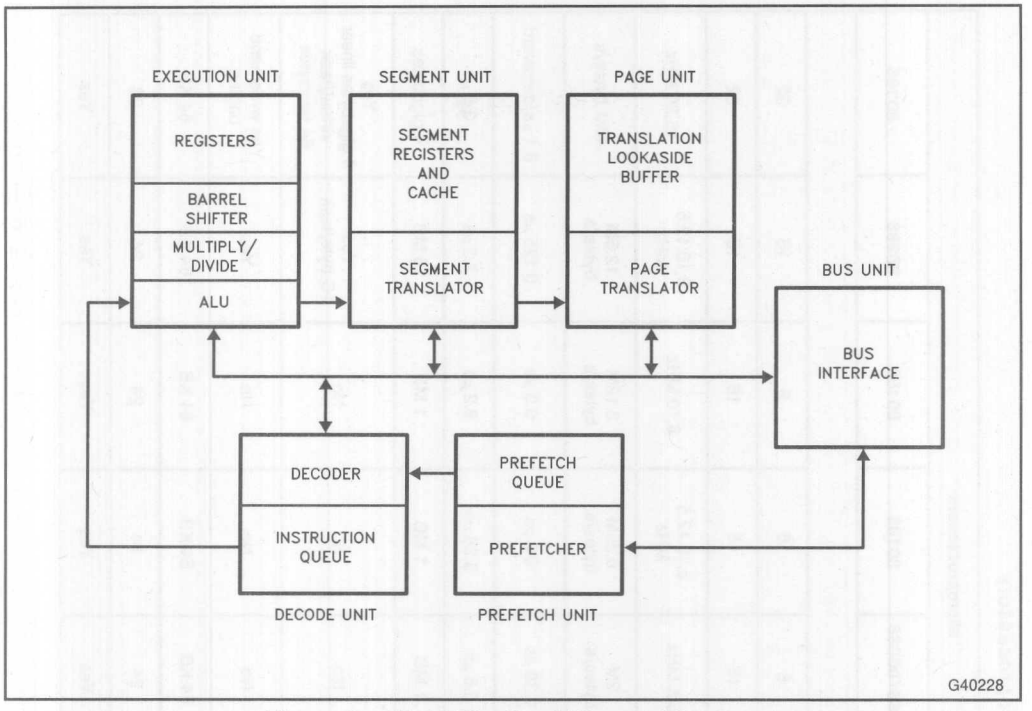


Figure 3. 80386 Pipelined Microarchitecture

Object-code compatibility with all 8086 family members (8086, 8088, 80186, 80188, 80286) means the 80386 offers immediate access to the world's largest microprocessor software base. Of special interest is the 80386's unique virtual machine capabilities, which allow direct execution of 8086 family software under new 32-bit operating systems.

The 80386 offers new testability and debugging features. Testability features include a self-test and direct access to the page translation cache. Four new breakpoint registers allow conditional or unconditional breakpoint traps on code execution or data accesses, for powerful debugging or even ROM-based systems.

Table 2. Microprocessors

Features	Microprocessors							
	8080A (MCS-80)	8085AH (MCS-85)	8086/80C86	8088/80C88	80186	80188	80286	80386
A. ARCHITECTURE								
Bus Interface (Bits)	8	8	16	8	16	8	16	32
Internal Data Path (Bits)	8	8	16	16	16	16	16	32
Clock Frequency (Speed Selection)	2,2.6,3 MHz	3,5,6 MHz	5,8,10 MHz	5,8 MHz	8,10,12.5 MHz	8,10 MHz	8,10,12.5 MHz	16,20 MHz
Bus Band Width (Max)	0.75M bytes/s	1.5M bytes/s	5M bytes/s	2M bytes/s	6.25M bytes/s	3.12M bytes/s	12.5M bytes/s	40M bytes/s
Register to Register (Min) Add Time (μs/data word)	1.3 μs	0.67 μs	0.3 μs	0.38 μs	0.2 μs	0.3 μs	0.125 μs	0.1 μs/dataword
Interrupt Response Time (Min)	7.3 μs	2 μs	6.1 μs	8.6 μs	3.36 μs	6.2 μs	2.3 μs	3.5 μs
Memory Addressability	64 KB	64 KB	1 MB	1 MB	1 MB	1 MB	16 MB	4 gigabytes
Virtual Memory	No	No	No	No	No	No	Yes 1G byte/task	Yes 4 gigabytes linear virtual/task 64 terabytes
On-Chip Memory Management and Protection	No	No	No	No	No	No	Yes	Yes w/demand paging
I/O Addressability	256 bytes	256 bytes	64 KB	64 KB	64 KB	64 KB	64 KB	64 KB
Addressing Modes	5	5	24	24	24	24	24	28
Coprocessor Interface	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Table 2. Microprocessors (Cont'd.)

Features		Microprocessors							
		8080A (MCS-80)	8085AH (MCS-85)	8086/80C86	8088/80C88	80186	80188	80286	80386
No. of Registers	Arithmetic	1	1	8	8	8	8	8	8
	Index	1	1	4	4	4	4	4	8
	Segment	0	0	4	4	4	4	4	6
	General Purpose	6	6	8	8	8	8	8	8
Code Compatibility		8080A Code		8086 Code					8086/80286
B. SOFTWARE SUPPORT									
High Level Languages		A wide variety of third-party software is available, see Software Section for Intel products.							
Operating Systems									
C. DEVELOPMENT SUPPORT: See Development Tools and Software Section									
D. KEY PERIPHERAL SUPPORT CHIPS: See Peripherals Section.									
Clock Generator		8224	On-Chip	82C84A	82C84A	On-Chip	On-Chip	82C284	82384 or PAL
System Controller		8228/38	On-Chip	82C88	82C88	On-Chip	On-Chip	82C288	TTL or PAL
Interrupt Controller		8259A/C59A	8259A/C59A	8259A/C59A	8259A/C59A	On-Chip	On-Chip	8259A/C59A	8259A/C59A/ 82380
DMA Controller		8257	8237A/C37A	8237/C37A 82258	8237/C37A 82258	On-Chip/ 82258	On-Chip 82258	82258	82258/82380
Timer-Counters		8253	8253/8254	8253/8254	8253/8254	On-Chip	On-Chip	8253/8254	8253/8254/82380
DRAM/Controller		8203/82C03	8203/82C03	8207/8208	8207/8208	8207/8208	8207/8208	8207/8208	PAL

Table 2. Microprocessors (Cont'd.)

Features		Microprocessors							
		8080A (MCS-80)	8085AH (MCS-85)	8086/80C86	8088/80C88	80186	80188	80286	80386
Chip Select/ Wait State Logic		TTL	TTL	TTL	TTL	On-Chip	On-Chip	TTL	TTL or PAL
Cache Controller		—	—	—	—	—	—	—	82385
Disk Controllers		82072	82072	82064/82072	82064/82072	82064/82072	82064/82072	82064/82072	82064/82072
Math Processor				8087	8087	8087	8087	80287	80387
Graphics Coprocessor		82716		82786	82786	82786	82786	82786	82786
E. GENERAL									
Package	Pins	40	40	40	40	68	68	68	132
	Type	DIP (P&D)	DIP (P&D)	DIP (P&D)	DIP (P&D)	LCC (Leadless) PLCC (Leaded) PGA	LCC (Leadless) PLCC (Leaded) PGA	LCC (Leadless) PLCC (Leaded) PGA	PGA
Power Supply		±5V, 12V	5V	5V	5V	5V	5V	5V	5V
Process Technology				NMOS CHMOS	NMOS CHMOS	NMOS	NMOS	NMOS	CHMOS
Military/Express		See Military and Express Sections.							

COPROCESSING—A NEW ARCHITECTURAL CONCEPT

The 8086 family brought with it a new architectural concept called "coprocessing." Basically, the task to be handled is partitioned into functional areas such as central processing, I/O processing, graphics, and numerics support. For each functional area, there is a device that extends the CPU's register and instruction sets. In this way, the cost of the specialized hardware is incurred only when required, and the chipset is optimized for specific applications.

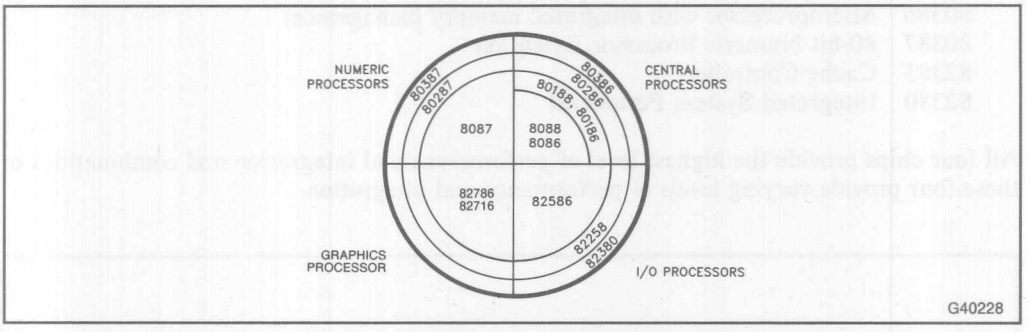


Figure 4. Processing—Function Partitioning

For numeric-intensive applications, the 8087, 80287, and 80387 numeric coprocessors extend the base architecture by adding eight 80-bit registers and about seventy instructions. By executing floating point routines in hardware, performance is improved up to 100 times. Eighty-bit precision maximizes accuracy while conforming to the proposed IEEE standard for floating point execution.

I/O intensive applications are supported by the 82258 (ADMA). This device enhances system performance by taking I/O load off the CPU. The 82258 is a 16-bit, high-speed (12.5M bytes per second transfer rate in 12.5 MHz 80286 systems) DMA processor with on-chip bus interface for the whole 8086 architecture (8086/88, 80186/188, 80286, 80386). Four independently programmable channels, including a multiplex or channel supporting 32 subchannels, can handle a large number of I/O devices.

The 82380 is a high performance 80386 companion chip that integrates a 32-bit DMA with system support peripherals to provide dramatic improvements in 80386 system performance. The 82380 enhances overall system performance by providing high data throughput (40M bytes per second transfer rate in 20 MHz 80386 systems) as well as having the internal bus arbitration and control logic needed for optimal use with the 80386 microprocessor.

The 82586 LAN Coprocessor in an I/O coprocessor that concurrently processes the ISO open system interconnect model levels 1 and 2 for local area networks with various topologies, framing techniques, contention detection schemes, and carrier methods.

Intel offers a complete range of solutions to meet the increasing graphics requirements of today's applications. The 82716 is a highly integrated, low-cost display controller for text and graphics applications. The 82786 provides high-performance graphics and high-quality text with advanced display capabilities.

COMPUTING ENGINE—EXTENSION OF 386 ARCHITECTURE

Intel's powerful Computing Engine provides the core for high-performance 32-bit microprocessor systems. The Computing Engine is a silicon extension of the 80386 architecture. The component parts are closely coupled together by pin-to-pin connections without the need for logic glue.

The 32-bit Computing Engine consists of:

80386 Microprocessor with integrated memory management
80387 80-bit Numeric Processor Extension
82385 Cache Controller
82380 Integrated System Peripheral

All four chips provide the highest level of performance and integration and combinations of these four provide varying levels of performance and integration.

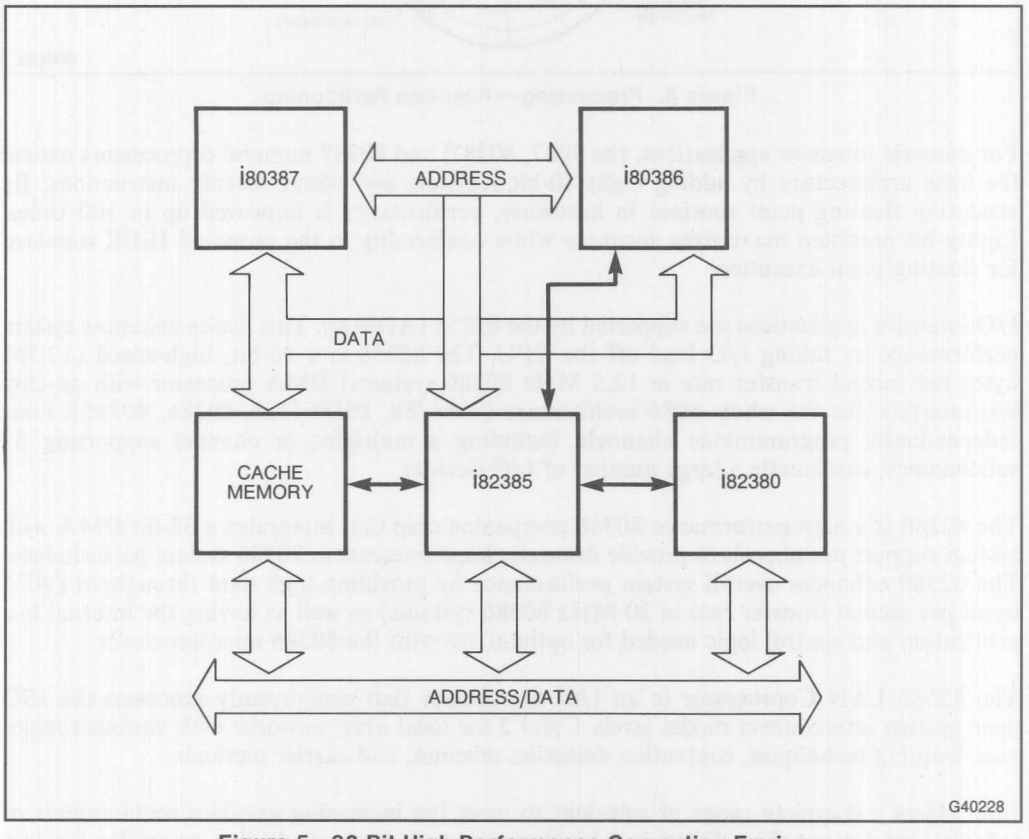


Figure 5. 32-Bit High Performance Computing Engine

Table 3. Numeric Processors

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
8087	Numeric Processing	Performs arithmetic, logical, and transcendental operations on 32-, 64-, and 80-bit floating point operands, 32- and 64-bit integers, and 18-digit BCD operands to greatly enhance speed of system. Floating point operations are approximately 100 times faster than equivalent CPU/ software routines. Accuracy is extended to 80 bits. Compatible with IEEE Standard 754.	8086/8088 80186/80188	With 5 MHz clock 14/18 μs 32-bit multiply: 19 μs 64-bit multiply: 27 μs Divide 39 μs With 8-MHz clock 32-bit multiply: 11.9 μs 64-bit multiply: 16.9 μs	Cerdip 40
80287	Numeric Processing	Performs arithmetic, logical, and transcendental operations on 32-, 64-, and 80-bit floating point operands, 32- and 64-bit integers and 18-digit BCD operands to greatly enhance speed of system. Floating point operations are approximately 100 times faster than equivalent CPU/ software routines. Accuracy is extended to 80 bits. Compatible with IEEE Standard 754. Has an asynchronous interface to the 80286, which allows the 80286 and 80287 to operate at different speeds in a system.	80286	With 5 MHz clock 14/18 μs 32-bit multiply: 19 μs 64-bit multiply: 27 μs Divide 39 μs With 8-MHz clock 32-bit multiply: 11.9 μs 64-bit multiply: 16.9 μs	Cerdip 40
80387	Numeric Processing	Supports all operations of the 80287, plus additional functions such as simultaneous sine and cosine. Meets IEEE Standard 754. Overall performance is four to six times 80287's (10 MHz).	80386	16 MHz and 20 MHz	68 Pin PGA

Table 4. I/O Processors

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
82586	Local Area Network Coprocessor	Implements Ethernet and IEEE 802.3 specifications and manages transmission/ reception processes w/o CPU intervention, including command and data buffer chaining network management and diagnostic functions.	8085AH 8086/8088 80186/80188	8 MHz	CC/48
82258	Advanced DMA Processor	16-bit, 4-channel DMA controller with on-chip bus interface for the whole 8086 architecture (8086/ 8088, 80186/80188, 80286 and 80386). Provides high-speed DMA transfers. Increases system performance because of its I/O processing capabilities through command and data chaining. Large number of medium- to slow-speed devices can be handled by the multiplex or channel, supporting 32 subchannels. Data manipulation is done through "on the fly" compare, translate, and assembly/disassembly operations. Remote mode of operation allows modular designs.	8086/88 80186/188 80286 80386	8M byte/sec in 8 MHz 80286 systems 4M byte/sec in 8 MHz 8086/80186 systems 16M byte/sec in 80386 systems	LCC/68 PGA
82380	High-Performance DMA Controller	32-bit, 8-channel DMA controller with internal bus arbitration and control logic for optimal use with the 80386 microprocessor. Enhances 386 system performance by transferring data between any combination of memory and/or I/O, with any combination (8, 16, or 32 bits) of data path widths. Assembles/disassembles data via a 32-bit internal temporary data storage register. Allows three programmable buffer transfer processes: single buffer, buffer auto-initialize, and buffer chaining. Covers the entire 32-bit physical address space of the 80386.	80386	32M byte/sec in 16 MHz 80386 systems 40M byte/sec in 20 MHz 80386 systems	PGA/132

Table 5. Graphics Coprocessors

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
82716	Video Storage Display Device	Highly integrated, low-cost display controller. Implements graphics displays with a minimum of chips. On-chip DRAM control, CRT control, video line buffers, color palette, and D/A converters. Flexible object structures support animation and windows. Can sync to external video sources for overlay.	All	25 MHz dot rate	CGA/68 PLCC/68
82786	Graphics Coprocessor	Provides high-performance graphics and high-quality text with advanced display control. Full support for graphics primitives at up to 2.5 million pixels per second and bit-mapped proportionally spaced text up to 20,000 characters per second. Hardware windows, zoom, cursor, pan, and scroll. Separate graphics/text and display content control units. Integral DMA and DRAM controllers. Low-power CHMOS. Linked list instructions.	All	20 MHz system clock 25 MHz video clock	CG/68

DEVELOPMENT TOOLS

Intel recognizes that developing a product based on an advanced microprocessor creates major challenges for an engineering group. Intel helps you meet these challenges and keep your project under control with a set of development tools tailored to the architecture you are using. These tools help you get your product development done within your schedule and budget targets by solving problems that waste valuable engineering time.

The first key to productive product development is to work on your product instead of developing and integrating tools. Intel has tools for each phase of your project, and each of them works smoothly with the others to form an effective, integrated tool set. The tools work on popular industry-standard systems, including the IBM PC/AT and PC/XT and compatible personal computers and Digital Equipment Corporation VAX/VMS Systems.

HIGH-LEVEL LANGUAGE SUPPORT

Each Intel microprocessor and embedded controller is supported by a set of high-level languages that have the three important elements of well-integrated tools:

The most important integration is between the tools and the processor. Intel assemblers and compilers are optimized around the architectures they support. That means better performance for your product. And efficient compilers mean you can write more of your code in high-level languages instead of assembly language.

Effective coding generally requires a family of compatible translators so that you can draw on the most appropriate language to implement each part of a design. PL/M, Pascal, C, FORTRAN, and Assembly language enjoy certain advantages over each other, depending on the application. You can link object modules from any of the Intel translators without further modifications.

The symbolic debugging power of Intel's debuggers is enhanced by communication between the translators and debuggers.

Table 6. Development Languages and Utilities

Product	Description
Assemblers	All Intel assemblers—and there's one for every major Intel component—provide full macro support.
PL/M	PL/M was the first high-level language designed expressly for microprocessors. It is a procedure-oriented language with data structuring facilities that gives the engineer full control over microprocessor-dependent architecture features. It is one of the most widely used tools in the microprocessor and microcontroller world.

Table 6. Development Languages and Utilities (Cont'd.)

Product	Description
iC	iC-86 is a true implementation of the C programming language defined by Keringhan and Ritchie and the proposed X3JIII ANSI standard. C is known for its flexibility and portability.
Pascal	Pascal-86 and Pascal-286 are supersets of ISO Pascal, with extensions for independent compilation and port I/O. They also embody advanced code optimization techniques to achieve extremely efficient programs.
FORTRAN	FORTRAN-86 and FORTRAN-286 are ANSI-77-standard compilers augmented with full 8087/80287 support and the ability to handle very large arrays (over 64 KB).
Utilities	Intel linkage utilities allow independent assembly and compilation of program modules. Library managers allow the management of standard modules and routines. In the case of 80286, a system builder is provided to allow easy configuration of a complex protected/memory-managed system.

HARDWARE AND SOFTWARE DEBUGGERS

Intel has made debuggers a part of each microprocessor family package, beginning with ICE-80, the world's original in-circuit emulator. Intel's debuggers have the power to find bugs early, while they are still easy to fix, and to find many bugs that would not otherwise be fixed without a major waste of engineering and schedule time.

Intel's popular In-Circuit Emulators (ICE) continue their key role in development projects, with full-speed, transparent debugging for Intel components. Intel ICE debuggers feature symbolic debugging, the ability to stop execution under user-determined conditions, trace collection, and emulation memory for program execution.

DEBUGGERS FOR 80386 FAMILY MICROPROCESSOR APPLICATIONS

Users of Intel's 80386 advanced, 32-bit microprocessor have a compatible set of software and hardware debugging tools available for their projects:

Debugging Task	Tool
High-level software debugging	PSCOPE Monitor 386 (P-MON 386)
Software debugging monitor	Debug Monitor 386 (D-MON 386)
Full-speed, transparent software hardware integration and debug	ICE-386 Emulator

PSCOPE Monitor (P-MON 386)

P-MON 386 is a high-level, hosted software debugger for 80386-based systems. It can access and control all of the 80386's visible user hardware resources without any resistance from the operating system. It can also be used to debug applications running under the control of an operating system.

P-MON 386 allows symbolic debugging of programs written in high-level languages. With the help of this debugger, a user can download an application program into the target prototype memory, set hardware and software breakpoints at symbolically specified addresses, trace program execution, and write patches to the program under development.

Debug Monitor 386 (D-MON 386)

D-MON 386 is an unhosted, EPROM-based software debug monitor that provides system-level debug support for 80386 systems. Using D-MON 386, a user can set hardware and software breakpoints, examine and modify memory and registers, and control program execution. This monitor can be configured to run on any 80386-based target board with a user-supplied communication driver and hardware initialization routine.

ICE™-386 In-Circuit Emulator

The ICE-386 In-Circuit Emulator provides hardware and software debugging for 80386-based designs. Its capabilities include emulation for the 80386 CPU and the 80287 and 80387 numeric processors. With ICE-386, programs can execute continuously at speeds up to 16 MHz or in a single-step mode. And it includes symbolic debugging to let users work in the context of their original programs.

Intel designed the 80386 and ICE-386 interactively to get the debugging power required of an advanced, 32-bit microprocessor, including non-intrusive access to internal processor activity. Breakpoints allow stopping emulation on specified instruction execution addresses or data addresses. Trace capability lets a user record program execution history prior to the break.

DEBUGGERS FOR 8086 AND 80286 FAMILY MICROPROCESSOR APPLICATIONS AND 80186/80C186 EMBEDDED CONTROLLER APPLICATIONS

Intel's debugging product line for the 8086, 80186, 80C186, and 80286 families of microprocessors features powerful tools covering the full range of development needs:

Debugging Task	Tool
Host-resident, high-level software debugging	PSCOPE
Transparent software/hardware integration and debug	I²ICE Emulator
Real-Time High Speed Development	ICE-186, ICE-286

Symbolic debugging automates a task that can eat up valuable development time and introduce error into the debug process. Symbolic debugging builds on the debug records loaded from the output of Intel assemblers and compilers—yet another example of the added debugging power gained from integration of development tools. Using user-defined names, the engineer has access to memory locations and program variables (including dynamic variables and high-level language data structures). The emulation tools combined with Intel's ASM and high-level languages provide a complete development solution.

PSCOPE High-Level Language Debugger

PSCOPE is a host-resident debugger that lets you execute and debug programs at the source code level. You can set break and trace points, examine memory, or simply follow program flow at the instruction, statement, or procedure level for programs written in PL/M, Pascal, C, FORTRAN, 8086 assembly language, or 80286 assembly language. PSCOPE even lets you make high-level language patches and store them for later use in updating source files.

The PSCOPE syntax, including debug procedures, is the same used by the I²ICE system, so when you move from software development to software/hardware integration, the user interface stays the same. There's no new learning curve to ascend, no lag in the development cycle.

I²ICE™ Integrated Instrumentation and In-Circuit Emulation System

I²ICE is proven in its ability to kill hardware and software bugs throughout the entire development process. Of course, I²ICE offers the high-level language symbolic debugging expected of a software debugger. It also integrates transparent emulation support up to 10 MHz for members of Intel's 8086, 80186, and 80286 families of microprocessors.

A full I²ICE configuration can simultaneously emulate four separate processors, stopping execution on an individual event, on an address range, on conditional events, and on interprocessor events. The system then displays a trace of execution or bus activity. Full-speed execution is possible using either target system memory or up to 288K bytes of emulator memory for each processor.

ICE™-186/ICE™-286 In-Circuit Emulation Development Tool

ICE-186/ICE-286 emulators deliver real-time in-circuit emulation for hardware and software development and debug environments for Intel's 80C186 and 80286 at speeds up to 12.5 MHz. Intel's assembler (ASM) and high-level languages, including C, PL/M, FORTRAN, and Pascal, are optimized for use with the component architectures and are fully supported by the ICE-186 and ICE-286 emulators. Popular features such as symbolic debug, 2K bytes of trace memory, and single-step program execution are standard on both emulators, allowing code execution to be monitored quickly and precisely.

The ICE-186 and ICE-286 emulators are hosted on IBM's PC AT, an affordable standard in today's engineering development environment. The emulators operate in standalone mode, allowing software development and debug before the user's prototype hardware is available.

Intel's emulators combined with language support deliver a tightly integrated, high-performance development environment. The ICE-186 and ICE-286 emulators are ideally suited for developing real-time applications requiring the full power of the 12.5 MHz 80C186 and 80286 microprocessors.

PERFORMANCE ANALYSIS

The iPAT Performance Analysis Tool provides real-time performance analysis and real-time test coverage of programs running on 8086/88, 80186/88, and 80286 microprocessors to help software engineers optimize code and improve software reliability.

Object code generated by Intel assemblers and compilers (C, PL/M, Pascal, and FORTRAN) can be analyzed symbolically to improve software efficiency and to validate test coverage. Any object code that lacks compiler information—but that can be run by Intel emulators and for which an absolute program map is available—can also be analyzed non-symbolically by the iPAT analyst.

DEBUGGERS FOR MCS®-51 AND MCS®-96 EMBEDDED CONTROLLER APPLICATIONS

Embedded controller applications are typically characterized by high performance requirements, a variety of asynchronous events, and a lot of on-chip activity. All of these characteristics add to the challenge of debugging your product. Each Intel embedded controller family has in-circuit debugging support to meet the challenges. The ICE and VLSiCE emulators share a user interface with I²ICE and PSCOPE, which saves learning time on projects with multiple processor types.

ICE™-5100 In-Circuit Emulator

ICE-5100 emulators give design engineers full-speed, real-time, non-intrusive control over 8051-family system debugging at clock speeds up to 16 MHz. Each emulator lets the user view and modify system activity at a symbolic, high-level language level, speeding and simplifying the development and debug phases of microcontroller system design. Three versions of ICE-5100 are available today. ICE-5100/252 supports HMOS and CHMOS versions of the following components: 8031, 8051, 8751, 8032, 8052, 8752, 80C31, 80C51, 87C51, 80C51FA, 83C51FA, and 87C51FA. The ICE-5100/452 support 80C452, 83C452, and 87C452. The ICE-5100/044 support 8344, 8044, 8744, and BITBUS components.

VLSiCE 96 In-Circuit Emulator

VLSiCE 96 provides real-time transparent debugging support for the 8x9x-90 and 8x9xBH (including 8x98) components of the MCS-96 family of 16-bit microcontroller components. It features full symbolic debugging; 64K bytes of mappable code memory; dynamic execution and data trace, including internal RAM accesses; and a break/state machine which allows stopping emulation or enabling trace on user-specified combinations of execution addresses, opcodes, data addresses and values, and selected PSW bits.

iSBE 96 8096 Emulator

The iSBE 96 debugger permits basic execution and debug of programs written for the MCS-96 family of 16-bit microcontrollers, within the emulator or in the user's target system. It features 18K bytes of mappable code memory and eight software breakpoints.

ICE™-196 PC In-Circuit Emulator

The ICE-196 PC provides real-time, transparent emulation of the 80C196KA microcontroller as well as an architectural evaluation and software execution vehicle. It features full symbolic debugging, 64K bytes of mappable code memory, execution address trace, execution address breakpoints, and integrated C and PL/M source code in trace and disassembly displays.

GENERAL TOOLS FOR ALL COMPONENT FAMILIES

EPROM Programming Support

Intel offers a full line of EPROM programmers for Intel devices. Through parallel development efforts, Intel is able to provide the earliest programming support for new Intel EPROMs, E²PROMs, KEPROM™s, and microcontrollers—with the fastest programming algorithms in the industry. The modular architecture of Intel EPROM programmers allows new support to be added with low-cost add-ons as they become available.

EPLD Development Tools

Intel's iPLDS Programmable Logic Development System makes it easy to use an Erasable Programmable Logic Device (EPLD) in your design. The iPLDS provides all the software, programming hardware, and documentation needed to convert random logic into a fully optimized, tested, and documented device.

AEDIT Text Editor

AEDIT is a full-screen text editor that can be either menu or command driven. It offers the ability to switch easily between two files or to view two files simultaneously through windows. Text entry and editing are further simplified through the use of macros, which allow you to save command clusters for later use.

DEVELOPMENT HOSTS

Intel's development tools are available on a selection of industry-standard host systems, giving users of Intel microprocessors and microcontrollers the ability to apply a combination of valuable elements in their development projects:

- Design and debug tools built around the needs of the specific microprocessor or microcontroller.
- Host systems optimized around installed equipment or the experience and needs of the development team:

VAX/VMS	Centralized development and project control for large teams, on an industry standard system.
PC/AT, PC/XT (DOS)	Versatile, standard, high-performance workstation.

- An open network to link tools across the various host environments.

Whether you run the Intel tools on a VAX minicomputer, an IBM PC/AT or XT, or an Intel system, the integration work is done before you install the tools on the system. You don't waste time getting the tools ready for the project.

NETWORK CONNECTIONS

Your host workstations can be a part of a complete development network using Intel's OpenNET™ implementation of the high-performance Ethernet local area network.

VMS, OpenNET, networking software lets you connect a VAX or MicroVAX II System to other OpenNET systems; PC-DOS, Intel's OpenNET NRM, iRMX, and XENIX systems. VMS-NET allows the VAX or MicroVAX to be configured as a File Server on the network. Any consumer PC-DOS, XENIX, or iRMX system can transparently access files resident at the VAX. VMS-NET also supports bidirectional file transfer between the VAX and all other systems in the network.

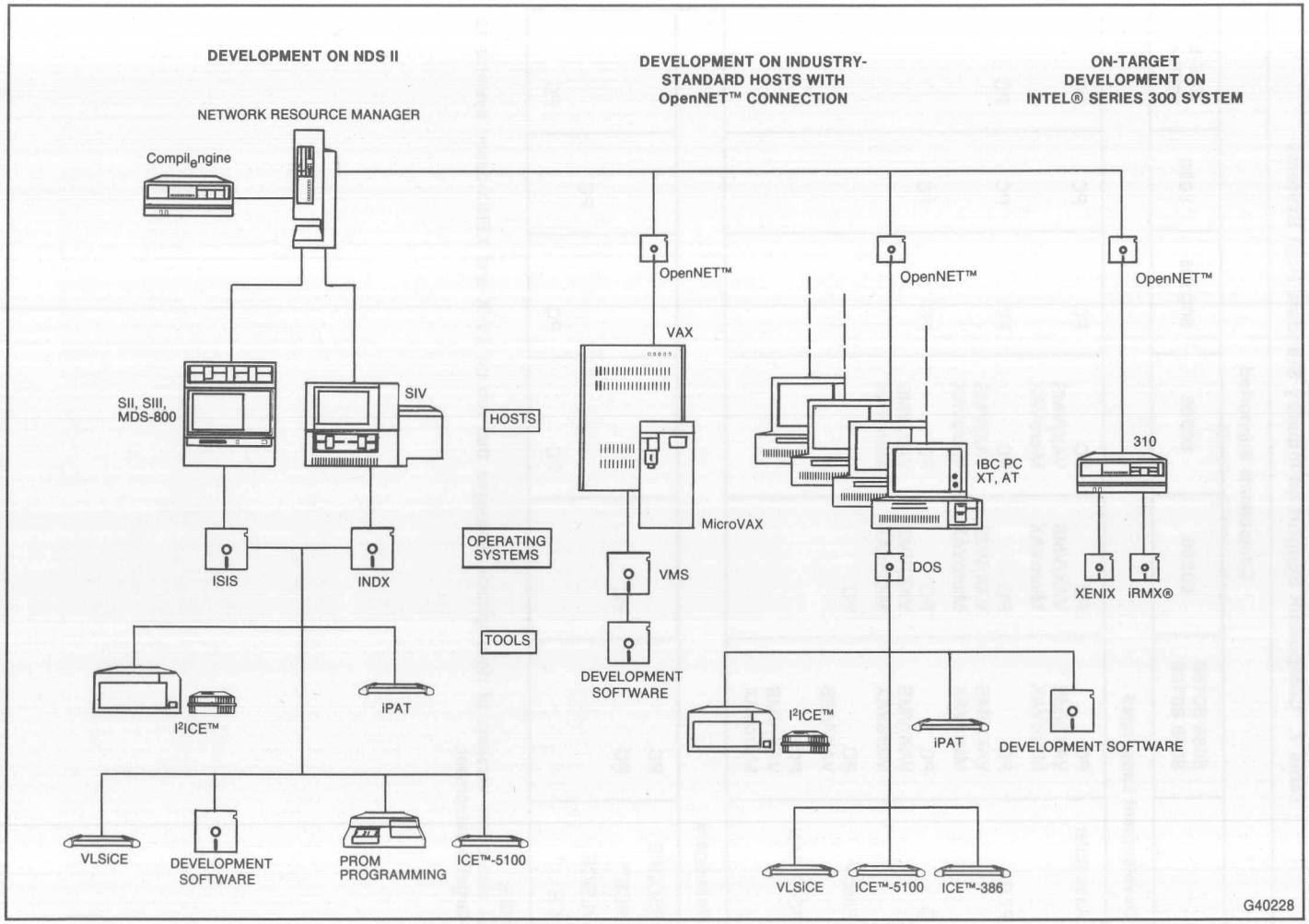


Figure 6. Tools Support on OpenNET™ Local Area Network

Table 7. Component Support on Industry Standard Host Systems

	Components Supported					
	8086 80186 8088 80188	**80286**	**80386**	**80C196**	**8096**	**MCS-51 RUPI-44**
Development Languages						
Assembler	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC	PC	PC
PL/M	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC	PC	PC
C	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC VAX/VMS MicroVAX	PC	PC	
Pascal	PC VAX/VMS	PC				
FORTRAN	PC VAX/VMS MicroVAX					
Debuggers						
PSCOPE	PC					
I²ICE™	PC	PC				
VLSiCE					PC	
ICE			PC	PC		PC

NOTES:
Intel also offers versions of development languages that run on iRMX and XENIX-based systems for on-target development.

SOFTWARE

Intel offers an extensive selection of operating systems, high-level languages, and development and debug support that is specifically tuned for microcontrollers, microprocessors, and microcomputer-based boards and systems. Intel also maintains the Insite™ Library of user software.

DEVELOPMENT SOFTWARE

Language and Utilities

For information on development systems, languages, utilities, and debuggers, see the Development Tools section.

Intel provides a range of microprocessor development software, from assembly to high-level languages. This software is available for a wide range of development environments.

The following table shows the software tools available for specific Intel microprocessors on Intel host systems and non-Intel computers.

Table 8. Intel Language/Host Summary

Language	Component Family	Host Code
Macro Assembler + Utilities	MCS-51 Family MCS-96 Family 8086 Family 80286 (Protected Mode) 80386	1,2 1,2 1,2,3,4 1,2,3,4 1,3,4
PL/M	MCS-51 Family MCS-96 Family 8086 Family 80286 (Protected Mode) 80386	1,2 1,2 1,2,3,4 1,2,3,4 1,3,4
PASCAL	8086 Family 80286 (Protected Mode)	1,2,3 1,2
FORTRAN	8086 Family 80286 (Protected Mode)	1,2,3 4
C	8086 Family 80286 (Protected Mode) 80386	1,2,3 1,2,3,4 1,3,4
ADA (Reference Sell)	8086 Family 80286 (Protected Mode) 80386	3 3 3

NOTE: Host Codes
1 = PC/XT or AT running DOS 3.0 or greater
2 = Intel 8086 Family Basic System (e.g., MDX Series IIIE, iRMX-86)
3 = VAX++/VMS Minicomputer VAX, MicroVAX++/VMS Minicomputer
4 + Intel 80286 (Protected) Basic System (e.g., iRMX-286 or XENIX 286)

Insite™ USER'S LIBRARY

Insite is a collection of programs that have been written by users of Intel microcomputers, single-board computers, and development systems. These programs are available on paper tapes, diskettes, or source listings and include monitors, conversion routines, peripheral drivers, translators, math packages, and even games. The library can also serve as a learning tool for users unfamiliar with assembly or high-level languages associated with Intel's microprocessors.

REAL-TIME SOFTWARE

When Intel developed the MULTIBUS architecture, Intel also recognized the importance of operating system technology. To support high-performance, time-critical applications in factory automation, industrial control, and other real-time applications, Intel in November 1977 introduced the first real-time operating system designed for VLSI microprocessors, the iRMX-80 Executive. From this first operating system has evolved the world's most popular family of real-time operating systems, providing real-time, multitasking, multiuser, multiprogramming support for Intel's single-board computers and microcomputer systems.

Real-time applications require special software. Operating systems designed for general business use typically lack essential real-time features making development of real-time applications either impossible or very expensive. Performance that may be acceptable for word processing and spreadsheet applications is very different from software controlling a nuclear reactor or steel rolling mill. In performance alone, Intel's real-time operating systems are typically 1,000 times faster than general purpose operating systems. Optimized for real-time performance, the operating systems provide ultra-fast context switching, task synchronization, memory-based message passing, and event-driven management of system resources.

Intel's real-time operating systems also include a rich set of real time programming facilities that simplify the design of real-time application software. Some of these facilities are inter-task communication through mailboxes and semaphores; interrupt management with custom exception handling; multiple task support; and preemptive, priority-based scheduling with round robin scheduling within priority levels.

All of Intel's real-time operating systems are composed of modular layers and are highly configurable, allowing the OEM to customize them to system requirements. And the operating systems are easily programmed into EPROM or PROM for highly reliable embedded systems.

The operating systems also provide the basis for a complete development environment. Included is a complete set of high-level languages for application programming, software development tools, software debuggers, and utilities. Available through worldwide service is software maintenance and application support. There is also a very active User's Group.

iRMX®-86 Operating System

The iRMX-86 operating system is a real-time multitasking, multiprogramming operating system for Intel's families of 16-bit microprocessors and single-board computers. The operating system provides a structured, efficient environment for a wide range of applications.

The iRMX-86 operating system offers users a modular set of system building blocks that can be tailored to create a wide variety of applications. Features include multitasking, multiprogramming, interrupt management device independence, tree-structured directories, file protection and control, and interactive debugging and interfaces to Intel and non-Intel products. The operating system provides the most cost-effective method available to develop software systems that take advantage of Intel's high-performance microprocessors.

iRMX®-286 Operating System

The iRMX-286 operating system takes advantage of the advanced features of the 80286 (and 80386) microprocessor with support for increased memory up to 16 MB, increased reliability and development support, support for the 80287 (and 80387) math coprocessor, increased real-time application utilities and system management commands, and complete compatiblity with the iRMX-86 operating system.

The iRMX-286 operating system is Intel's most complete real-time operating system, with a full set of real-time programming facilities and multitasking, multiuser, and multiprogramming support for Intel's Single Board Computers and microcomputer systems, including Intel's newest 80386-based boards and systems.

iRMK™ Real-Time Kernel

The iRMK real-time kernel is a 32-bit real-time executive designed and optimized for extremely fast execution on the 80386. Ideal for very time-critical applications, the iRMK kernel provides predictable response times for use of its rich set of real-time services. Services include task, time, and interrupt management, mailboxes and semaphores for intertask synchronization and communication, and a memory pool manager.

The executive provides the kernel of a real-time operating system in a very compact design, as small as 8K bytes, and is easily programmed into EPROM for embedded applications. The kernel supports both MULTIBUS and MULTIBUS II, with optional support available for MULTIBUS II message passing. It is also designed for easy customization and enhancement, for incorporation into proprietary designs.

iSDM™ System Debug Monitor

The System Debug Monitor iSDM provides a set of development tools for debugging both iRMX-86 and iRMX-286-based applications directly on a target single-board computer system. The package includes a monitor for the single-board computer that can load programs into the target system, execute the programs at full speed or in single-step mode, set break-

points, examine and modify registers and memory, and support addition of custom commands. The complete package includes the necessary software, EPROMs, RS232C cables, and documentation to use the monitor for standalone, in-target debugging and for development and debugging applications from a remote host.

Full Language Support for iRMX®-Based Systems

Intel's iRMX-86 and iRMX-286-based systems are completely supported by a wide variety of popular languages and utilities with which to build fast, real-time, multitasking applications. Included are the latest version of C, FORTRAN, PASCAL, BASIC, PL/M, and Macro Assembler for Intel's 8086 and 80286 processors. Previously developed applications using any of these languages port easily to iRMX-based systems with minimal source code modifications.

The iRMX languages run only on iRMX-86 or iRMX-286 but are fully compatible with Intel's software development languages, allowing users to develop programs on Intel's development systems and then easily move it to an iRMX system.

In addition to the wealth of languages available, iRMX-based systems are complemented by utilities with which to create and manage object modules.

Intel's Universal Development Interface (UDI) and Object Module Format (OMF) enable several users to write different modules of an application, in different languages, then link them together, providing users with the ability to mix languages on a single application.

The iRMX languages allow OEMs to select the correct language for their application. For technical applications, FORTRAN or PASCAL can be used; for systems programming PL/M can be used; and for optimization, Macro Assembler can be used.

Because the high-level languages are actually resident on the iRMX-based system, OEMs can pass application software directly on to end users. End users may then tailor the OEM's system to better meet application needs by writing programs using the same languages.

The iRMX language products enable programmers to write the smallest, fastest programs available in high-level languages, due to the compiler's superior ability to optimize code.

It is also possible to make iRMX operating system calls directly from FORTRAN, PASCAL, and PL/M. This means that application developers can take full advantage of the iRMX multitasking capability, whereby multiple applications execute concurrently on the operating system.

32-Bit Languages for iRMK™-Based Systems

Intel also provides 32-bit languages for iRMK kernel applications, including PL/M 386, C386, and ASM 386, and a set of 80386 utilities. These languages provide additional support for the 80386's 32-bit OMF with debug records and are upwardly compatible from the 8086 and 80286 languages. Care was taken to optimize the object code generated for high execution speed, matching the RMK and 80386 performance edge in MULTIBUS and MULTIBUS II applications.

Table 9. Real-Time Operating Systems and High-Level Languages

Operating Systems	Languages Supported	Component[1]	MULTIBUS[2] Boards	Systems[3]
iRMX-86	Assembler PASCAL 86/88 FORTRAN 86/88 BASIC-86 Interpreter C-86 PL/M 86	8086, 8088 80186, 80286 Family	iSBC® 86/05 iSBC 86/12A iSBC 86/14 iSBC 86/30 iSBC 86/35 iSBC 88/25 iSBC 88/40 iSBC 186/03 iSBC 286/10A iSBC 12/14/16	86/380 86/310 286/380 286/310 310AP
iRMX-286	PL/M 386 PASCAL 286 FORTRAN 286 C 286 ASM 286 ASM 86	80286 80386	iSBC 286/10A iSBC 286/12/14/16 iSBC 386/21/22/24/28 iSBC 386/31/32/34/38 Plus drivers for I/O boards	286/310 286/380 310AP
iRMK	PL/M 386 C 386 ASM 386 80386 Utilities	80386	iSBC 386/21/22/24/28 iSBC 386/31/32/34/38 iSBC 386/116 iSBC 386/120	320

NOTES:
1. See Microprocessor Section.
2. See Single Board Computer Section.
3. See OEM Systems Section.

XENIX OPERATING SYSTEM

Intel offers the XENIX 286 R3.5 operating system specifically configured and optimized for the System 320 supermicro system. XENIX 286 R3.5 for the 80386 is a fully licensed and enhanced version of UNIX System III that has been codeveloped by Microsoft Corp. and Intel Corp. This is a multiuser, multitasking memory-protected operating system that utilizes the features of the 80386 and 80387 to provide a high-performance, cost-effective UNIX engine. The integration of operating system features onto the 80386 chip also provides an unparalled amount of software compatability between different machines running the XENIX operating system. Intel's product engineering, evaluation, documentation, and support groups are involved to insure that the software has been thoroughly tested for reliability and ease of use by systems builders.

XENIX LANGUAGES AND APPLICATIONS

Intel provides a set of high-level languages and applications packages for the XENIX operating system. Many of these packages are sold by Intel to provide single-stop shopping for system's customers. Due to the need for a wide variety of software for a commercially oriented system, Intel also runs an active third-party software program that provides systems support and marketing assistance to third-party developers who sell the resulting products directly to Intel OEMs.

Table 10. XENIX Languages and Applications

Product	Description	Applicable Standards
XENIX 286 C Compiler	Included with the XENIX 286 operating system. High-performance compiler for the C programming language for the 80386. Provides full implementation as per Kernighan Ritchie book along with extensive type checking and error handling, 80387 floating point support and large model segmentation support.	—
XENIX 286 FORTRAN	See Software section for description.	ANSI 77
XENIX 286 BASIC	Industry standard Microsoft BASIC Interpreter provides interactive development and execution of the most popular dialect of the BASIC language.	ANSI x3.60 1978 Subset
XENIX 286 COBOL Compiler (XNX2867) and Run-Time Incorporation Fees (XNX2868)	Offering of Microfocus COBOL, a mainframe caliber package for ANSI 1974 programs. Supports easy migration of existing programs (through support of standard), easy program development (through interactive environment and FORMS II visual programming tool), and cost effective pass through (using lower cost run-time only package for volume shipments).	ANSI x3.23 1974 to Federal High-Level
XENIX 286 PL/M	See Development Tools Section for description.	—

Table 11. XENIX Operating System and High-Level Languages

Operating Systems	Languages Supported	Components[1]	MULTIBUS[2] Boards	Systems[3]
XENIX 386 R3.0 licensed version of UNIX System III	C language FORTRAN Cobol BASIC Interpreter PL/M	80286 Family 80386 Family	iSBC 286/10A iSBC 286/12/14/16 iSBC 386/21/22/24/28 iSBC 386/31/32/34	

NOTES:
1. See Microprocessor Section.
2. See Single Board Computer Section.
3. See OEM Systems Section.

PERIPHERALS

Intel offers an extensive set of peripheral devices to augment microprocessor capabilities. The six major families of peripherals include: support peripherals, memory controllers, CRT display controllers, slave processors, math processors, and data communication controllers.

MATH PROCESSORS

These devices process the data sent by the host CPU. Math and IEEE floating point calculations are implemented in hardware. This increases performance, reduces software overhead, and frees up the processor for other tasks.

Table 12. Math Processors

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
8087	Numeric Processing	Performs arithmetic, logical, and transcendental operations on 32-, 64-, and 80-bit floating point operands, 32- and 64-bit integers, and 18-digit BCD operands to greatly enhance speed of system. Floating point operations are approximately 100 times faster than equivalent CPU/software routines. Accuracy is extended to 80 bits. Compatible with IEEE Standard 754.	8086/8088 80186/80188	With 5 MHz clock 32-bit multiply: 19 μs 64-bit multiply: 27 μs Divide 39 μs	Ceramic/40
80287	Numeric Processing	Performs arithmetic, logical, and transcendental operations on 32-, 64-, and 80-bit floating point operands, 32- and 64-bit integers, and 18-digit BCD operands to greatly enhance speed of system. Floating point operations are approximately 100 times faster than equivalent CPU/software routines. Accuracy is extended to 80 bits. Compatible with IEEE Standard 754. Has an asynchronous interface to the 80286, which allows the 80286 and 80287 to operate at different speeds in a system.	80286	With 5 MHz clock 14/18 μs 32-bit multiply: 19 μs 64-bit multiply: 27 μs divide 39 μs With 8 MHz clock 32-bit multiply: 11.9 μs 64-bit multiply: 16.9 μs	Ceramic/40

Table 12. Math Processors (Cont'd.)

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
80387	Numeric Processing	Supports all operations of the 80287, plus additional functions such as simultaneous sine and cosine. Meets IEEE Standard 754. Overall performance is four to six times 80287's (10 MHz).	80386	16 MHz and 20 MHz	PGA/68

SLAVE PROCESSORS

Slave processors consist of a family of user-programmable devices. They are Universal Peripheral Interfaces (UPI™) for control functions where no standard controller exists. These UPI devices are flexible single-chip microcomputers with on-chip CPU, ROM or EPROM, RAM, I/O ports, and a slave interface to the master system CPU. They allow the designer to integrate random control logic and to add custom control interfaces to a system.

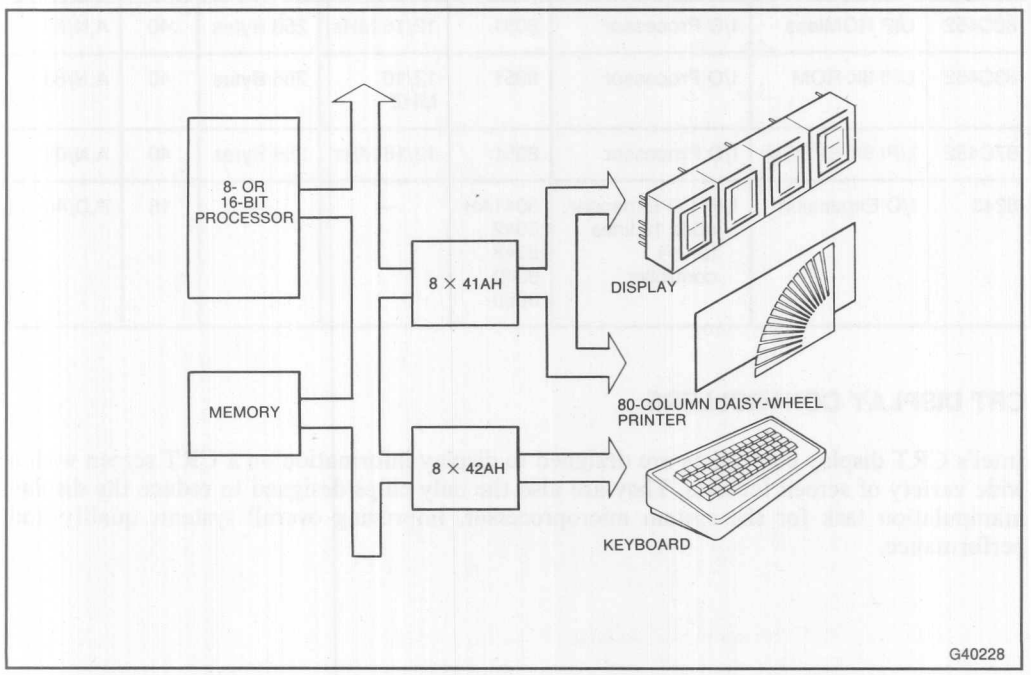


Figure 7. Universal Peripheral Interfaces (UPI™) for Non-Standard Control

UPI products include pin-compatible ROM and EPROM versions to allow prototyping/ debugging or rapid feature upgrades in production. The instruction set is based upon the industry-standard 8048.

The UPI family is supported with a line of products for code development: development systems, assembler, in-circuit emulators (ICE), and PROM programmers.

Table 13. Slave Processors

Device Number	Function	Description	CPU	Speed	RAM	I/O Lines	Package Type/ No. of Pns
8041AH	UPI 1K ROM	Programmable Peripheral	8048	6 MHz	128 Bytes	18	P/40 N/44
8741AH	UPI 1K EPROM	Programmable Peripheral	8048	6 MHz	128 Bytes	18	P/40 N/44
8042AH	UPI 2K ROM	Programmable Peripheral	8049	12 MHz	256 Bytes	18	P,D,N/ 40 N/44
8742AH	UPI 2K EPROM	Programmable Peripheral	8049	12 MHz	256 Bytes	18	P,D/40 N/44
80C452	UIP ROMless	I/O Processor	8051	12/16 MHz	256 Bytes	40	A,N/68
83C452	UPI 8K ROM	I/O Processor	8051	12/16 MHZ	256 Bytes	40	A,N/68
87C452	UPI 8K EPROM	I/O Processor	8051	12/16 MHz	256 Bytes	40	A,N/68
8243	I/O Expansion	UPI I/O Expander, adds 16 lines to UPI controller	8041AH 8042 8048 8049 8050	—	—	16	P,D/40

CRT DISPLAY CONTROLLERS

Intel's CRT display controllers are designed to display information on a CRT screen with a wide variety of screen formats. They are also the only chips designed to reduce the display manipulation task for the system microprocessor, improving overall systems quality and performance.

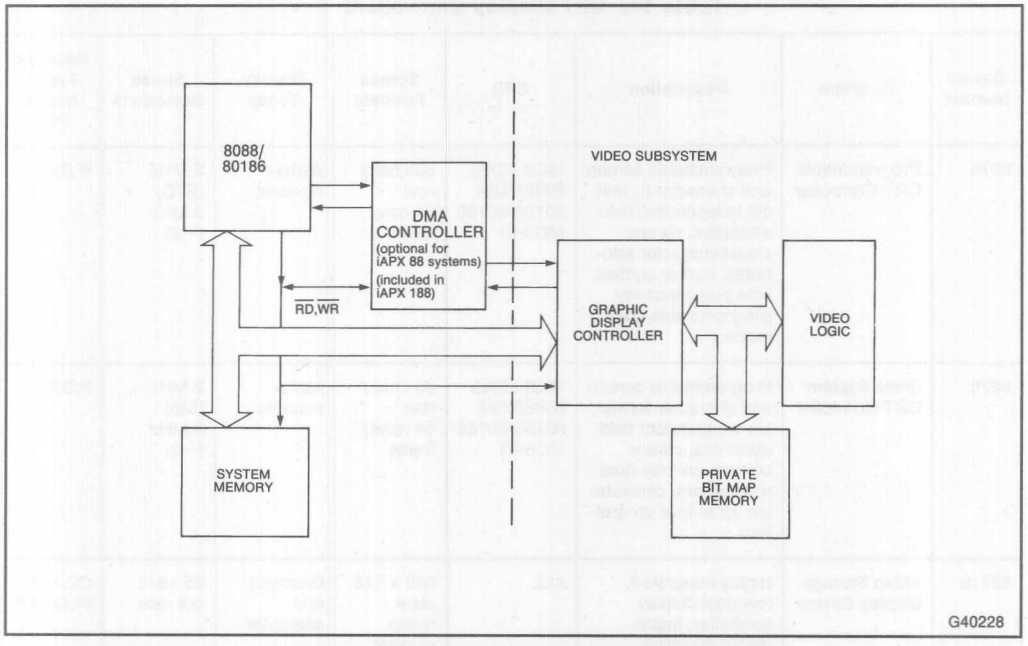


Figure 8. CRT Display Controller Subsystem

Table 14. CRT Display Controllers

Device Number	Function	Description	CPU	Screen Formats	Display Types	Speed Selections	Package Type/ No. of Pins
8275	Programmable CRT Controller	Programmable screen and character format, six independent field attributes, eleven visual character attributes, cursor control, light pen capability, programmable DMA mode.	MCS 80/85 8086/8088 80186/80188 MCS-51	80 char./ row 64 row/ frame	Alpha-numeric	2 MHz (STD) 3 MHz (−2)	P,D/40
8276	Small System CRT Controller	Programmable screen and character format, six independent field attributes, cursor control, on-chip dual row buffers, cascadable up to four controllers.	MCS 80/85 8086/8088 80186/80188 MCS-51	80 char./ row 64 rows/ frame	Alpha-numeric	2 MHz (Std) 3 MHz (−2)	P,D/40
82716	Video Storage Display Device	Highly integrated, low-cost display controller. Implements graphics displays with a minimum of chips. On-chip DRAM control, CRT control, video line buffers, color palette, and D/A converters. Flexible object structures support animation and windows. Can sync to external video sources for overlay.	ALL	640 x 512 pixel mono or color	Graphics and character	25 MHz dot rate	CGA/68 PLCC/68
82786	Graphics Coprocessor	Provides high-performance graphics and high-quality text with advanced display control. Full support for graphics primitives at up to 2.5 million pixels per second and bit-mapped proportionally spaced text up to 20 thousand characters per second. Hardware windows, zoom, cursor, pan, and scroll. Separate graphics/text and display content control units. Integral DMA and DRAM controllers. Low-power CHMOS. Linked list instructions.	ALL	Up to 3.6 mega pixel resolution	Mixed text and graphics. Display selected from output by multiple applications within many windows. One to 256 colors.	20 MHz system clock. 25 MHz video clock	CG/68

MEMORY DISK CONTROLLERS

The memory disk controller family of peripherals integrates the logic required to interface dynamic RAM, floppy disks, and Winchester disks to microprocessors.

The dynamic RAM controllers supply all three functions necessary in any dynamic RAM design: row/column address multiplexing, refresh, and arbitration. A single device replaces ten to fifteen TTL packs and the delay line. The 8207 extends the level of integration to include support for a dual-port interface, bank interleaving, and complete ECC control with the 8206. The 82C08 is a single-chip low-power solution for DRAM control. It is ideal for low-power and portable systems.

Three disk controllers interface a microprocessor to mass storage devices. The 8272A and 82072 control 3½," 5¼," and 8" floppy disk drives, while the 82064 controls Winchester disk drives using the ST506 standard interface.

Table 15. Memory Disk Controllers

Device Number	Function	Description	CPU	Speed	Memory Size	Package Type/ No. of Pins
8203	16K/64K DRAM Controller	Provides all logic to interface 64K DRAMs to any microprocessor.	ALL	Zero to three wait states	256K bytes	D/40
8206	Error Detection and Correction	Single-bit correction Double-bit detection	ALL	55 ns	8-bit to 80-bit words	A/R/68
8207	64K/256K DRAM Controller	Interfaces 64K/256K DRAMs while providing a dual-port interface bank interleaving and ECC control.	ALL	0 wait states up to 16 MHz	2M bytes	A/R/68
82C08	64K/256K CMOS DRAM Controller	Interfaces 64/256K DRAMs (including 256K x 4) to high-performance 8-bit and 16-bit microprocessors. Has power-down feature, which keeps memory alive using battery backup. Single chip solution saves boardspace.	ALL	Zero wait states up to 20 MHz	1M bytes	P/48 N/68
8272A	Floppy Disk Controller	Programmable single or double-density controller for up to four drives.	ALL	500 KB/s 300 KB/s 250 KB/s	3½," 5¼," or 8" floppy	P,D/40
82072	Floppy Disk Controller	CHMOS high-integration floppy disk controller.	ALL	1 MB/s 500 KB/s 300 KB/s 250 KB/s	3½," 5¼," or 8" floppy	P/40 N/44
82064	Winchester Disk Controller	CHMOS Winchester disk controller for ST506 interface drives.	ALL	5 MB/s	3½," 5¼," or 8" Winchester disk	P/40 N/44
82385	Cache Controller	32-bit high-performance cache controller with posted writes and bus watching. Software transparent.	80386	Zero wait states 16 MHz 20 MHz	32 KB cache 4 GB main memory	A/132

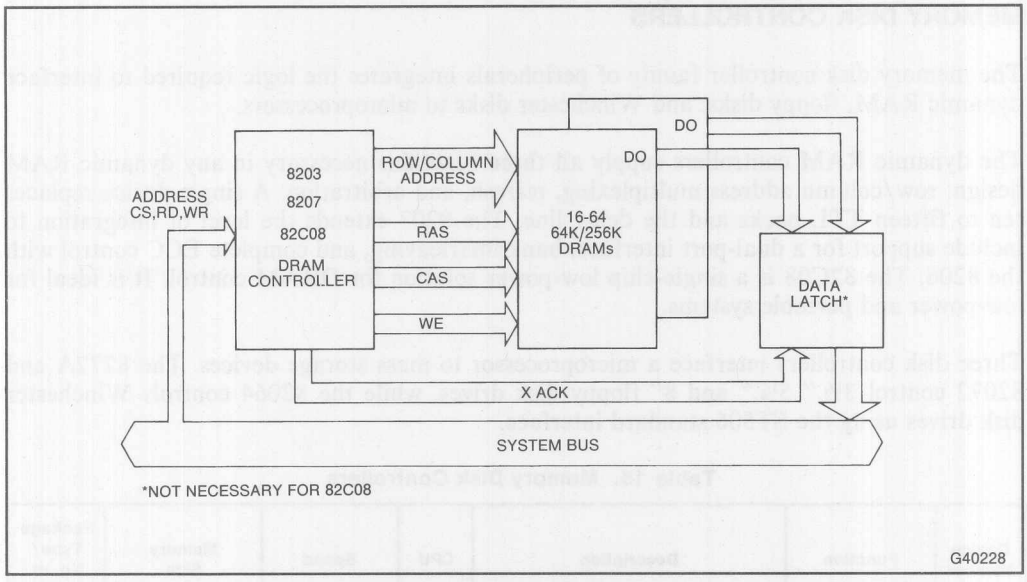


Figure 9. Dynamic RAM Subsystem

Interrupt Controllers

These provide faster response to real-time events in a large system without requiring the processor to poll for the source of peripheral service requests.

Table 16. Interrupt Controllers

Device Number	Function	Description	CPU	Package Type/ No. of Pins
8259A	Programmable Interrupt Controller	Eight vectored interrupts, cascadable to sixty-four.	ALL	P,D/28
82380	Programmable Interrupt Controller	Enhanced 82C59A Interrupt Controller. Fifteen external, five internal interrupts. Cascadable to 120 (multi-function support peripheral).	80386	A/132

Multiplexed Memory Components

These components can communicate over the multiplexed address/data bus of the MCS-85, 8088, or 80188 processors, eliminating the need for address latching.

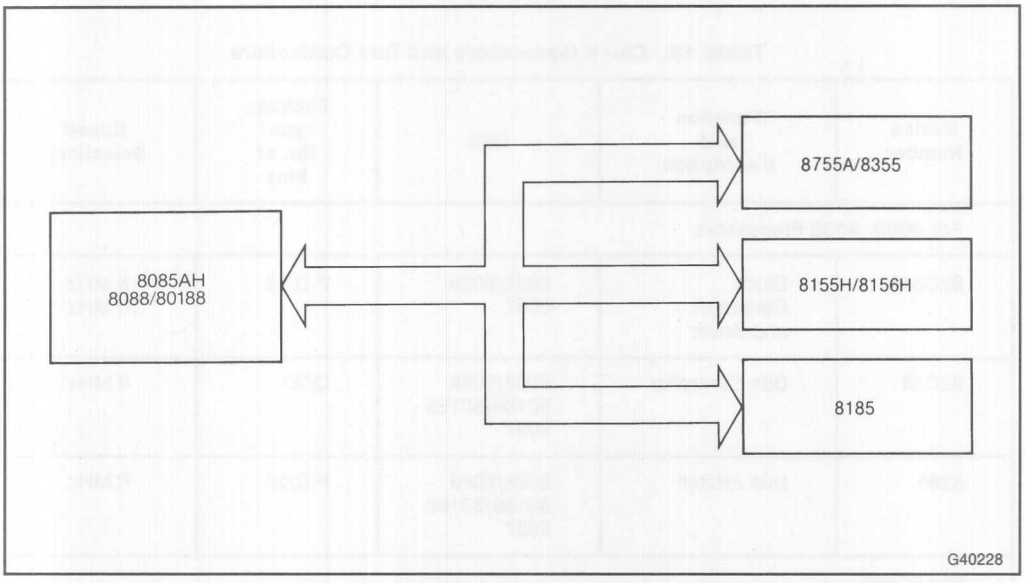


Figure 10. Multiplexed Memory Components

Table 17. Multiplexed Memory Components

Device Number	Function	Description	CPU	Access Time	Package Type/ No. of Pins
8155H/ 8156H	Static RAM, I/O and Timer	256 bytes RAM; 14-bit counter/timer, 22 parallel I/O-ports; internal address latch.	8085AH 8088 80188	330 ns (−) 400 ns (Std)	P,D/40
8185	Static RAM	1K X 8-bit RAM; internal address latch; low standby power requirements.	8085AH 8088 80188	250 ns (−2) 350 (Std)	P,C/18
8355	ROM and I/O	2K X 8-bit masked ROM; two bidirectional 8-bit ports; internal address latch.	8085AH 8088 80188	300 ns (−2) 450 ns (Std)	P,D/40
8755A	EPROM and I/O	2K X 8-bit erasable PROM and I/O; erasable with UV light; electrically reprogrammable; interchangeable with 8355.	8085AH 8088 80188	300 ns (−2) 450 ns (Std)	DB/40

Clock Generators and Bus Controllers

These devices include: clock generators, bus drivers, bus transceivers, bus controllers, bus arbiters, and latches. They provide the drive, control signals, and timing to directly support interfacing to the industry-standard MULTIBUS architecture.

Table 18. Clock Generators and Bus Controllers

Device Number	Function and Description	CPU	Package Type/ No. of Pins	Speed Selections
For 8086/8088 Processors				
82C84A	Clock Generator and Driver	8086/8088 8087	P,D/18	8 MHz 10 MHz
82C88	Bus Controller	8086/8088 80186/80188 8087	D/20	8 MHz
8289	Bus Arbiter	8086/8088 80186/80188 8087	P,D/20	8 MHz
For 80286				
82C284	Clock Generator	80286	D/18	8 MHz
82C288	Bus Controller	80286	D/20	8 MHz 10 MHz 12.5 MHz

SUPPORT PERIPHERALS

Intel's support peripherals are designed with a consistent bus interface that makes them compatible with the entire Intel microprocessor line, from 8 to 16 bits. As a result, the user can leverage previous design and learning investments with each microprocessor upgrade. This support includes the following products.

Timer-Counters, Parallel I/O, Keyboard Controllers

These devices are used for baud rate generation, event counting, motor controls, and real-time clock functions.

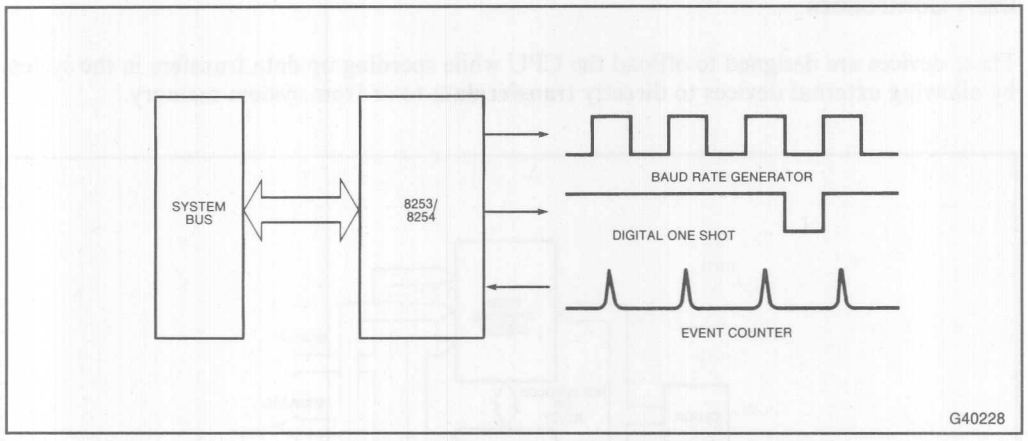


Figure 11. 8253/8254 Time/Counter

Table 19. Timer-Counters, Parallel I/O, Keyboard Controllers

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
8253	Timer/Counter	Three independent 16-bit counters.	ALL	2.6 MHz count rate	P,D/24
8254	Timer/Counter	Three 16-bit counters—superset of the 8253.	ALL	10 MHz count rate	P,D/24
82C54	Timer/Counter	CHMOS, Three 16-bit counters, compatible with 8254.	ALL	10 MHz count rate	P,D/24 N/28
8255A	Parallel I/O	24 TTL-compatible I/O Lines.	ALL	—	P,D/40
82C55A	Parallel I/O	CHMOS, 2 TTL-compatible I/O Lines.	ALL	—	P,D/40 N/44
8256AH	All Basic Support Functions	Serial I/O, parallel I/O, timer/ counters, and interrupt control (8251A, 8253, 8255A, and 8259A).	ALL	UART: 1M bytes Counters: 0.5 MHz	P/40
8279	Keyboard Controller	64-key keyboard and display scan control.	ALL	—	P,D/40

DMA Controllers

These devices are designed to offload the CPU while speeding up data transfers in the system by allowing external devices to directly transfer data to or from system memory.

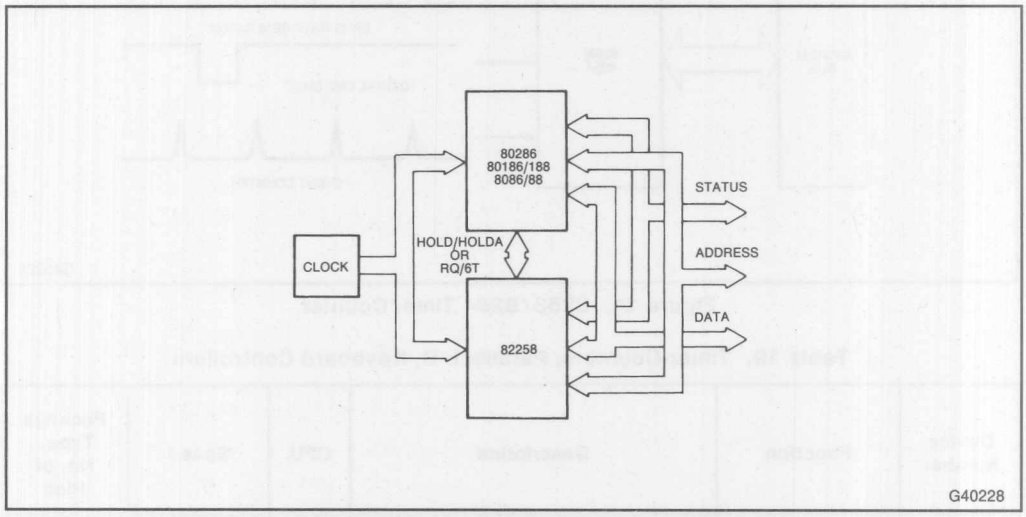


Figure 12. 82258 in an Intel Advance Processor Architecture System

Table 20. DMA Controllers

Device Number	Function	Description	CPU	Speed	Package Type/ No. of Pins
		16-bit, four-channel DMA controller with on-chip bus interface for the whole 8086 architecture (8086/8088, 80186/80188, 80286, and 80386). Provides high-speed DMA transfers.			
82258	Advanced DAM Processor	Increases system performance because of its I/O processing capabilities through command and data chaining. Large number of medium to slow speed devices can be handled by the multiplex or channel supporting thirty-two subchannels. Data manipulation is done through "on the fly" compare, translate, and assembly/disassembly operations. Remote mode of operation allows modular designs.	8086/88 80186/188 80286 80386	8M bytes/sec in 8 MHz 80286 systems. 4M bytes/sec in 8 MHz 8086/80186 systems. 16M bytes/sec in 80386 systems.	LCC/68 PGA
8237A	High-Performance DMA Controller	Four independent DMA channels, can be cascaded to support any number of channels, additional feature of memory-to-memory transfer.	ALL	1.6M bytes/sec.	P,D/40
82C37A	High-Performance DMA Controller	CHMOS, four independent DMA channels, can be cascaded to support any number of channels, additional feature of memory-to-memory transfer.	ALL	1.6M bytes/sec.	P,D/40
8257	DMA Controller	Four channel DMA controller.	8080A 8085AH	960K bytes/sec (3 MHz).	P,D/40
82380	High-Performance 32-Bit DMA Controller	Eight independently programmable channels. Transfers data between any combination of memory and/or I/O, with any combination (8, 16, or 32 bits) of data path widths. Supports byte assembly/disassembly and buffer chaining process. Optimized for use with the 80386 microprocessor. (Multi-function support peripheral.)	80386	32M bytes/sec in 16 MHz 80386 systems. 40M byte/sec in 20 MHz 80386 systems.	A/132

MICROCOMMUNICATIONS COMPONENTS

Intel is dedicated to improving your company's performance and productivity with a broad spectrum of communication networking products ranging from our OpenNET Networking Product family, including systems, boards, and networking software, to communication components, modules, and systems that provide a new range of versatile, low-cost alternatives for connecting micro-, and minicomputers to mainframes.

Intel's experience and leadership in state-of-the-art VLSI technology is leading the way in providing innovative, flexible, and reliable communications networking solutions for our customers. Only through continued advances in VLSI can you unlock the communication bottlenecks that exist in today's multivendor office and industrial environments.

Intel's Microcommunications—that is, VLSI-based digital communication products and services—are providing the vital elements lacking among various networks employed throughout the world. Advances in VLSI have allowed Intel to design advanced microprocessor architectures such as the 80286 and 80386. These microprocessors, when combined with various communication products provide the high performance, flexibility, and reliability necessary to simplify and improve communications, thus improving the decision-making processes and creating a new level of information accessibility for your organization.

Microcommunications Components Solutions

Intel's microcommunications components solutions include:

- Local Area Network (LAN) components
- Telecommunication Components, Modules, and Software
- Wide Area Network (WAN) Components—UARTs, Modems, ISDN

The remainder of this section discusses each of Intel's Microcommunication component offerings. Microcommunications board, software and system products are discussed in the Microcommunications Systems section and also under the Microcommunication Products subsection of Microcomputer Systems.

For more in-depth technical information, refer to the Microcommunication Handbook for data sheets, article reprints, application notes, and other technical information.

LOCAL AREA NETWORK CONTROLLERS

Intel provides the broadest line of CSMA/CD devices available. High-performance applications can utilize the 82586 LAN Coprocessor that supports IEEE 802.3 Ethernet and Cheapernet. Cost-sensitive applications can use the 82588 Single Chip LAN Controller that supports industry standards for PC Networking: the IEEE StarLAN standard and IBM PC Network. The 82586 is supported by iNA 960 Network software for quick time to market.

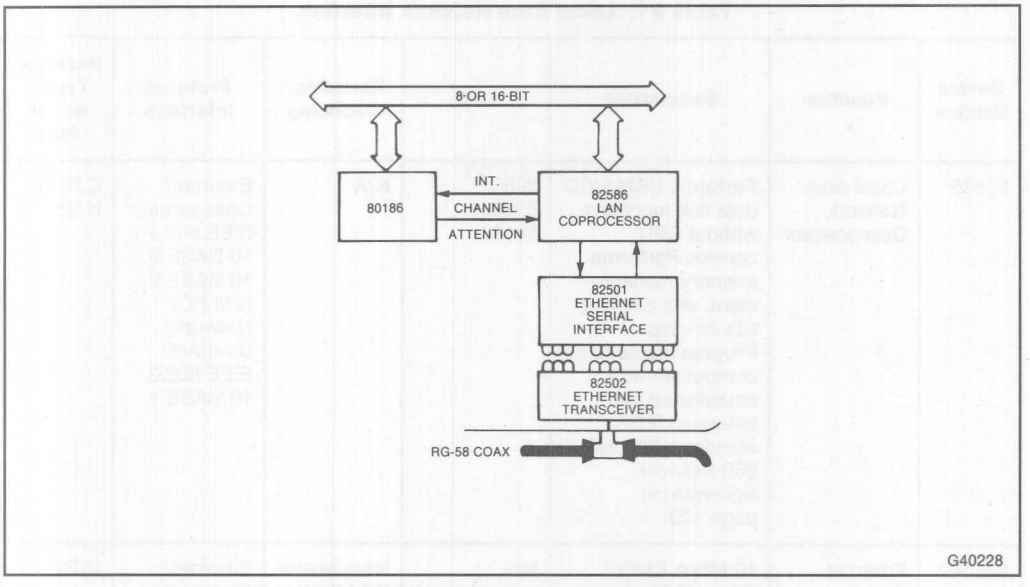


Figure 13. IEEE 802.3/Cheapernet Configuration

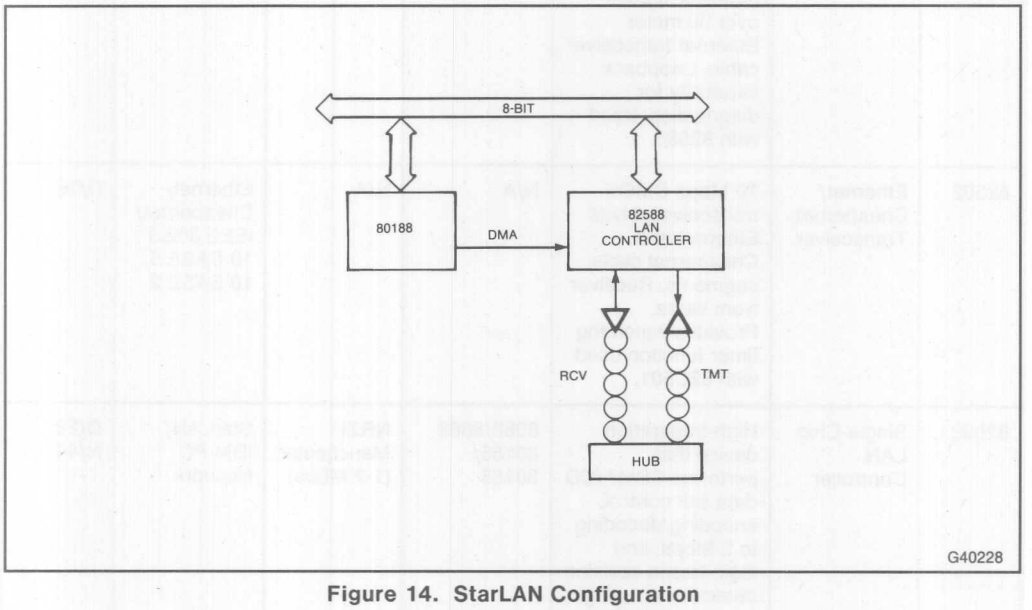


Figure 14. StarLAN Configuration

Table 21. Local Area Network Interface

Device Number	Function	Description	CPU	Encoding/ Decoding	Protocol Interface	Package Type/ No. of Pins
82586	Local Area Network Coprocessor	Performs CSMA/CD data link functions without CPU control. Performs memory management, and diagnostics on-chip. Programmable to be compatible with established and emerging IEEE standard. See iNA 960 Network Software on page 123.	8086 80186/ 80188	N/A	Ethernet/ Cheapernet/ IEEE 802.3 10 BASE 5 10 BASE 2 IBM PC/ Network/ StarLAN IEEE 802.3 10 BASE 1	C,P/48 N/68
82C501	Ethernet Serial Interface	10 Mbps CMOS Ethernet Manchester encoder/ decoder. Drives and receives signals over 50 meter Ethernet transceiver cable. Loopback capability for diagnostics. Used with 82586.	N/A	Manchester (10 Mbps)	Ethernet/ Cheapernet	D/20
82502	Ethernet/ Cheapernet Transceiver	10 Mbps CMOS transceiver drives Ethernet and Cheapernet cable segments. Receiver from same. Provides watchdog timer function used with 82C501.	N/A	N/A	Ethernet/ Cheapernet/ IEEE 802.3 10 BASE 5 10 BASE 2	D/16
82588	Single-Chip LAN Controller	High-Integration device that performs CSMA/CD data link control, encoding/decoding to 2 Mbps, and logic-based collision detection in a single chip. Ideal for low-cost LAN applications.	8086/8088 80186/ 80188	NRZI Manchester (1-2 Mbps)	StarLAN/ IBM PC Network	D/28 N/44

SERIAL DATA COMMUNICATION CONTROLLERS

The serial communication devices support all the serial standard protocols; asynchronous, byte synchronous and bit synchronous protocols. The interconnection can be local or remote. For remote channels, modem control lines are provided.

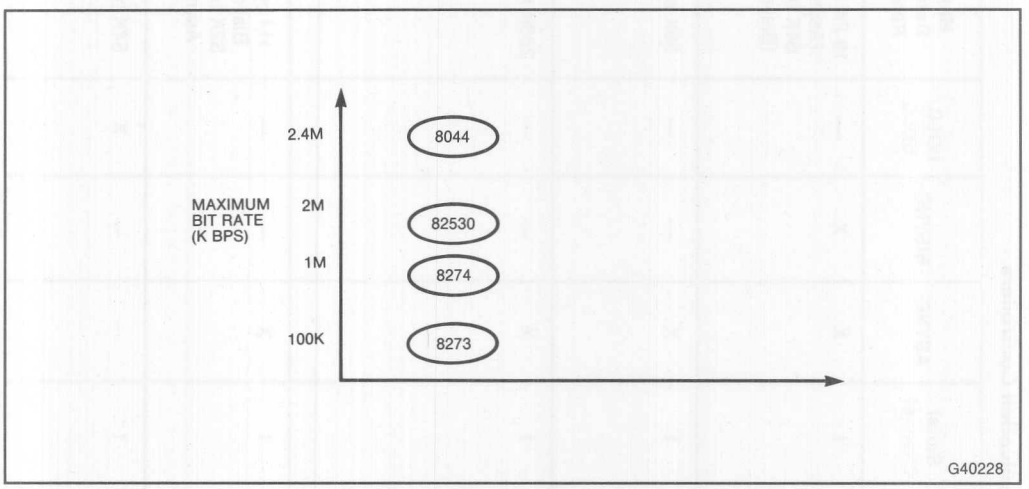


Figure 15. SDLC/HDLC Controllers

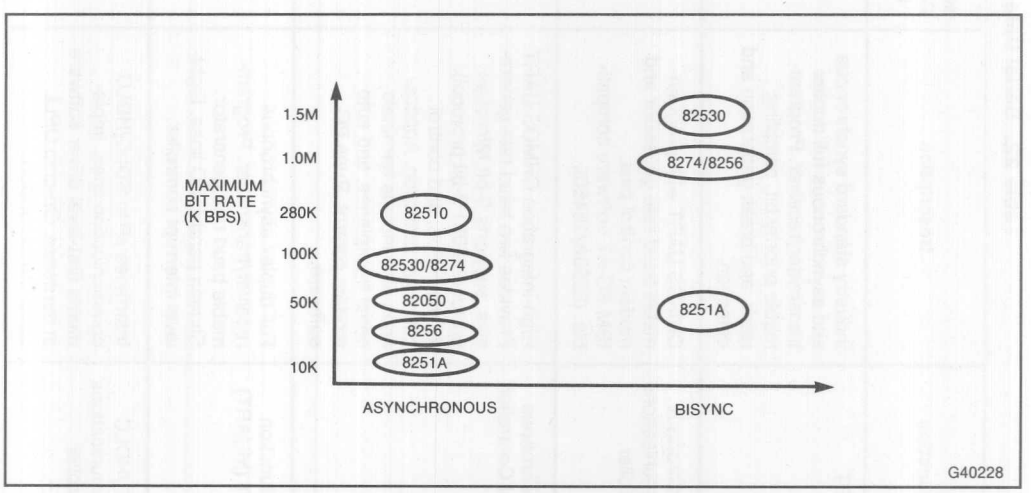


Figure 16. Asynchronous Controllers

Table 22. Serial Data Communication Controllers

Device Number	Function	Description	Modem Control Lines	Serial Channel	ASYNC	BISYNC	HDLC/ SDLC	Max Data Rate	Package Type/ No. of Pins
8251A	USART	Industry standard synchronous and asynchronous full duplex transmitter/receiver. Programmable priority bit, sampling rates, and break generation and detection.	4	1	X	X	—	19 2K bps (Async) 64K bps (Bisync)	D,P/28
82050	Asynchronous Communications Controller	CHMOS UART with programmable baud rate generator and modem control pins. IBM PC-AT software compatible. (8250A/16450).	>	1	X	—	—	56K bps	N,P/28
82510	Asynchronous Serial Controller	High-integration CHMOS UART. Provides two baud rate generators, supports 9-bit MicroLan protocol (8051 9-bit protocol), 4-byte FIFOs, and control character detection. Applications also include terminals, serial backplanes, and auto modem control. Runs PC software.	7	1	X	—	—	288K bps	N,P/28
8256AH	Multifunction UART (MUART)	Full duplex asynchronous receiver/transmitter. Programmable baud rate generator. Sixteen parallel I/O lines. Eight-level interrupt controller.	1	1	X	—	—	1M bps Bisync 32K bps Async	P/40
8273	SDLC/HDLC Communications Controller	Interfaces μP to SDLC/HDLC communication lines. Implements first-level driver software in hardware. On-chip DPLL Loop mode support.	3	1	—	—	X	64K bps	D,P/40

Table 22. Serial Data Communication Controllers (Cont'd.)

Device Number	Function	Description	Modem Control Lines	Serial Channel	ASYNC	BISYNC	HDLC/ SDLC	Max Data Rate	Package Type/ No. of Pins
8274	Multiprotocol Serial Controller (MPSC)	Multiprotocol device with several μP interface options, four independent DMA channels on-chip.	4 per channel	2	X	X	X	580K bps	D,P/40
82530	Serial Communications Controller (SCC)	Dual-channel multiprotocol controller with on-chip baud rate generators, digital phase locked loops, various data encoding/decoding schemes, and extensive diagnostic capabilities	4 per channel	2	X	X	X	1.5M bps	D,P/40 N/44
8344	High-Performance 8-Bit Microcontroller With On-Chip Serial Communication Controller	8051 microcontroller core with high-performance serial communication controller that can automatically respond to SDLC primary station commands. On-chip DPLL supports loop and non-loop.	2	1	—	—	X	2.4M bps (half-duplex)	P/40 N/44
8044	—	8344 with 4K bytes of on-chip ROM.	2	1	—	—	X	2.4M bps	P/40 N/44
8744	—	8344 with 4K bytes of on-chip EPROM.	2	1	—	—	X	2.4M bps	C/40

GENERAL PURPOSE INTERFACE BUS (GPIB) CHIP SET

The GPIB (General Purpose Interface Bus) has been with us now for twelve years. In 1975, the IEEE released the 488 Standard that defines an interface for programmable instruments. Since that time, the GPIB has been designed into hundreds of instruments, both in the United States and overseas. The interface is also being used for devices other than programmable instruments. Desktop computers and calculators use the GPIB to communicate with peripherals such as plotters, floppy disks, etc. In short, the GPIB enjoys wide acceptance and usage.

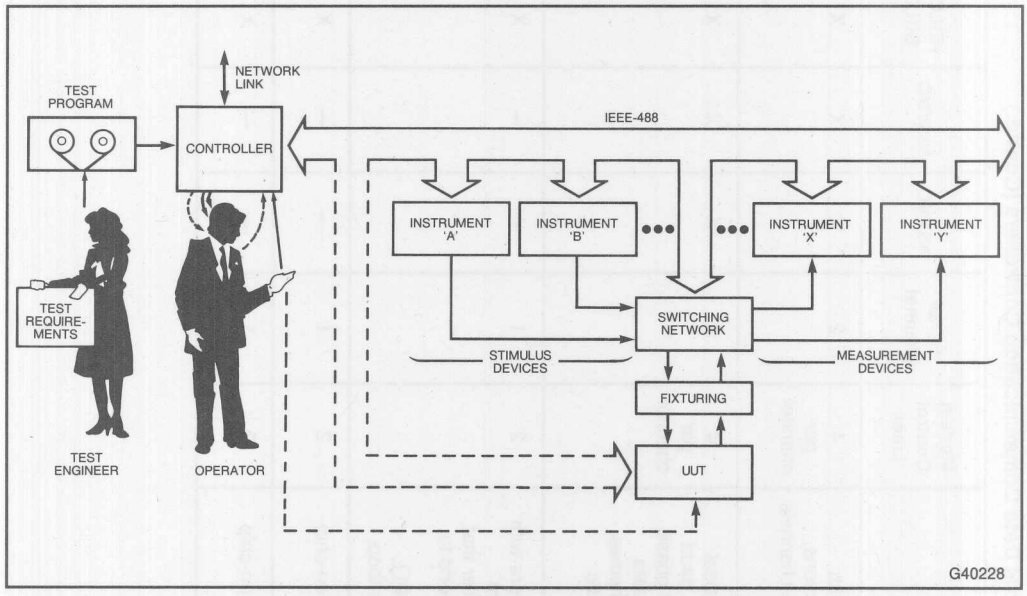


Figure 17. General Form of an Instrument System

GPIB Products

The 8292 implements the controller function of the IEEE Standard 448-1978 (GPIB, HP-IB, IEC Bus, etc.). In order to function, the 8292 must be used with the 8291 Talker/Listener and suitable interface and transceiver logic. In this configuration, the system has the potential to be a complete GPIB controller when driven by the appropriate software.

GPIB Controllers

The 8291A/8292 are all the building blocks needed to implement the different types of nodes used on the GPIB (IEEE-488) parallel instrumentation bus.

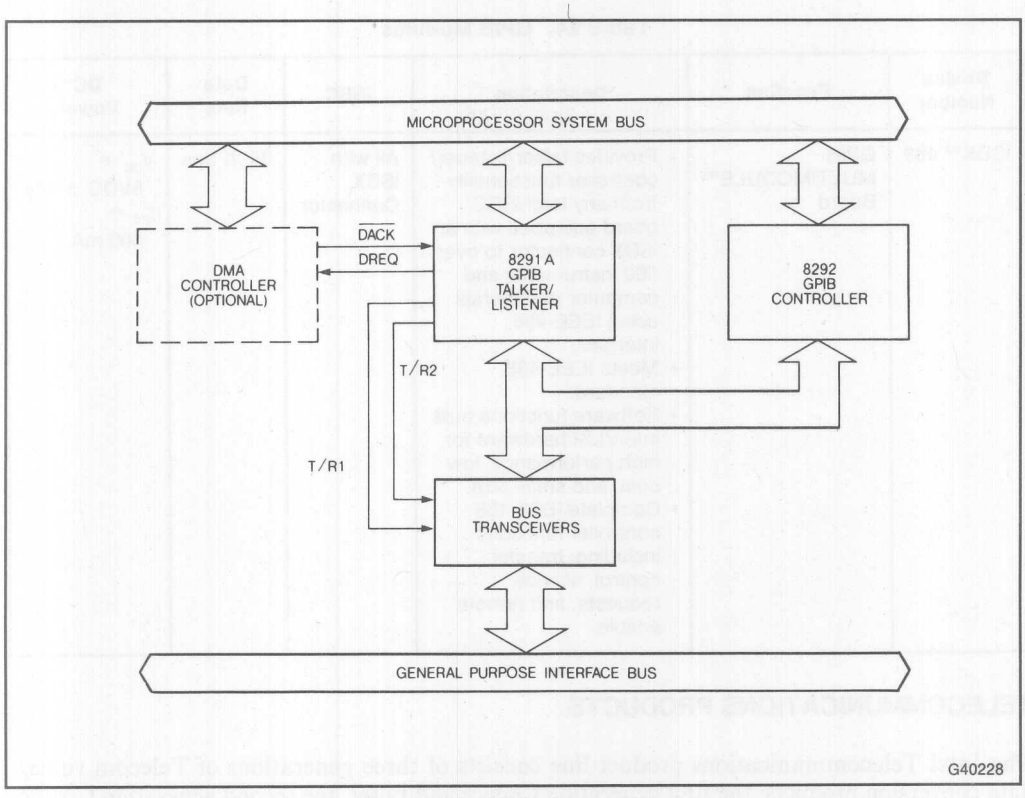


Figure 18. GPIB Controllers

Table 23. GPIB Controllers

Device Number	Function	Description	CPU	Data Rate	Package Type/ No. of Pins
8291A	GPIB Talker/Listener	Complete talker/listener device that adheres to IEEE-488 standard. Implements all nine talker/listener functions. On-chip programmable end-of-sequence register for automatic end of message.	8085AH 8086/8088 80186/80188 8048AH/8049AH 8051/8096	350K bps max	P,D/40
8292	GPIB Controller	Connects with the 8291A to form a complete IEEE-488 standard interface talker/ listener/controller. Built-in bus lock-up timers for high system reliability.	8085AH 8086/8088 80186/80188 8048AH/8049AH 8051/8096	N/A	P/40

Table 24. GPIB Modules

Device Number	Function	Description	iSBC	Data Rate	DC Power
iSBX™ 488	GPIB MULTIMODULE™ Board	• Provides talker/listener/ controller functionality from any Intel iSBC board equipped with an iSBX connector to over 600 instruments and computer peripherals using IEEE-488 interface. • Meets IEEE-488 standard. • Software functions built into VLSI hardware for high performance, low cost, and small size. • Complete IEEE 488 controller functions including: transfer control, service requests, and remote enable.	All with iSBX Connector	350K bps	V_{cc} = 5VDC ± 5% I_{cc} = 600 mA

TELECOMMUNICATIONS PRODUCTS

The Intel Telecommunications product line consists of three generations of Telecom voice/data conversion products: the first generation Codecs and Filter, the second generation Combo Family, and the third generation of Advanced Telecom Components (iATC) for Integrated Services Digital Network (ISDN) applications.

In addition, Intel makes available a 2400 bps full-duplex modem, providing a complete system solution in two chips.

The following lists all available Telecom component products:

First Generation
- 2910A Industry Standard μ-Law Codec
- 2911A Industry Standard A-Law Codec
- 2912A Industry Standard Filter

Second Generation
- 2913, 29C13 — 20-Pin μ/A-Law Codec
- 2914, 29C14 — 28-Pin μ/A-Law Codec
- 2916, 29C16 — 16-Pin μ-Law Codec
- 2917, 29C17 — 16-Pin A-Law Codec

Third Generation
- 29C48 — Terminal SLD Combo
- 29C50A — Medium Feature Programmable Combo

29C51 — High-Feature Programmable Combo
2952 — Line Card Controller
29C53 — Four-Wire ISDN Transceiver
LEK 29C53 — Line Card Evaluation Kit
TEK 29C53 — Terminal Evaluation Kit
Modem-89024 — 2400 bps, FDX Modem Chip Set

Codecs/Filter/Combos

Intel's PCM Codecs, Line Filters, and Combo Chips are special purpose A/D and D/A converters and filters for use in PCB Line Circuits in telephony switching and transmission systems. The wide dynamic range (78 dB) and minimal conversion time (80 μsec) also make them ideal for such other applications as voice store and forward, digital echo cancellers, secure communications systems, and satellite earth stations.

The 2910A/11A PCM Codecs and 2912A PCM Line Filter are industry standard components which have been in production for ten years. We have shipped more than 25,000,000 Codec Filters or combos.

The new industry standard telephony line circuits are the 2913 and 2914 Codec/Filter Combo Chips. These devices have a fully differential internal architecture to improve crosstalk, idle channel noise, and power supply rejection. In addition, the transmit and receive channels are totally separate to further reduce crosstalk and to improve performance in asynchronous operation. The charge-redistribution DAC has essentially eliminated gain tracking error. This superior transmission performance is combined with surprisingly low power dissipation through the use of our advanced HMOS-E technology, a proven technology which has supported the production of millions of 2764 EPROMs. For applications requiring especially low power levels (e.g., telephone handsets), CMOS combo chips are available.

Table 25. Performance Comparison

Features	2910A PCM Codec μ-Law	2911A PCM Codec A-Law	2912A PCM Line Filter	2913 Codec/Filter Combo Chip	2914 Codec/Filter Combo Chip	2916/17 Codec/Filter Combo Chip
Fixed Data Rate Mode	1.536, 1.544, 2.048 MHz	1.536, 1.544, 2.048 MHz	Compatible	1.536, 1.544, 2.048 MHz	1.536, 1.544, 2.048 MHz	2.048 MHz
Variable Data Rate Mode	No	No	Compatible	64 kHz to 2.048 MHz	64 kHz to 2.048 MHz	64 kHz to 2.048 MHz
μ/A-Law	μ-Law	A-Law	N/A	Selectable	Selectable	16:μ17:A-Law
Analog Loop Back	No	No	No	No	Yes	No
Power Down Mode	Yes	Yes	Yes	Yes	Yes	Yes
Cross Talk	−80 dB	−80 dB	−70 dB	−80 dB	−80 dB	−71 dB
Idle Channel Noise Transmit/Receive	10 dBrnc0	−78 dBm0p	6/2 dBrnc0	15/11 dBrnc0	11/15 dBrnc0	15/11 dBrnc0 −75/−79 dBm0p
Gain Tracking, S/D, Frequency Response	Meets D3/D4	Meets CCITT G.712	Meets D3/D4 & CCITT G.712	Exceeds D3/D4 & CCITT G.712	Exceeds D3/D4 & CCITT G.712	Exceeds D3/D4 & CCITT G.712
Pin Count	24	22	16	20	24	16

ISDN Components

Intel's Advanced Telecom Components (iATC) architecture was conceived to insure optimum ISDN system compatibility. This means that careful consideration was given to ISDN equipment requirements on component functional partitioning. Requirements such as application flexibility, modularity, upgrade paths, efficient interconnects, broad source of suppliers, etc., have been factored in and are evident in the iATC architecture.

Figure 19 shows how the iATC family addresses the requirements in switching system equipment. In this diagram, two fundamental cards are shown: the analog line card and the digital line card. Each of the cards interface to a common backplane through a Line Card Controller (2952). The backplane carries circuit switched voice/data and control information. The SLD interface efficiently transfers voice, data, control, and signaling/status over a three-wire link consisting of a ping-pong data lead plus two clock signals.

The iATC component family provides modular building blocks for ISDN terminal applications. The 29C53 transceiver can be combined with an iATC-combo chip and appropriate microprocessor to tailor the solution to application needs. Figure 20 depicts a typical ISDN connection to a PC.

Our ISP188 software completes OSI layers 2 and 3. Co-developed with DGM&S. ISP188 is made up of literally thousands of lines of code. And it's ready to run today. As a result, you save man-years in development time and get to market quicker.

When you use this complete package of components and software, it will take care of the most common design issues associated with ISDN protocols and standards.

We're also working on compatibility issues with the world's largest telecommunications equipment supplies. In fact, we've recently concluded an agreement with AT&T that ensures interoperability between our devices and theirs.

As a result you can begin to design with this kit right away and be certain of compatibility with ISDN systems today and tomorrow.

To help you with your ISDN design we also offer a full range of development tools, such as our Terminal Evaluation Kit and our Line Card Evaluation Kit.

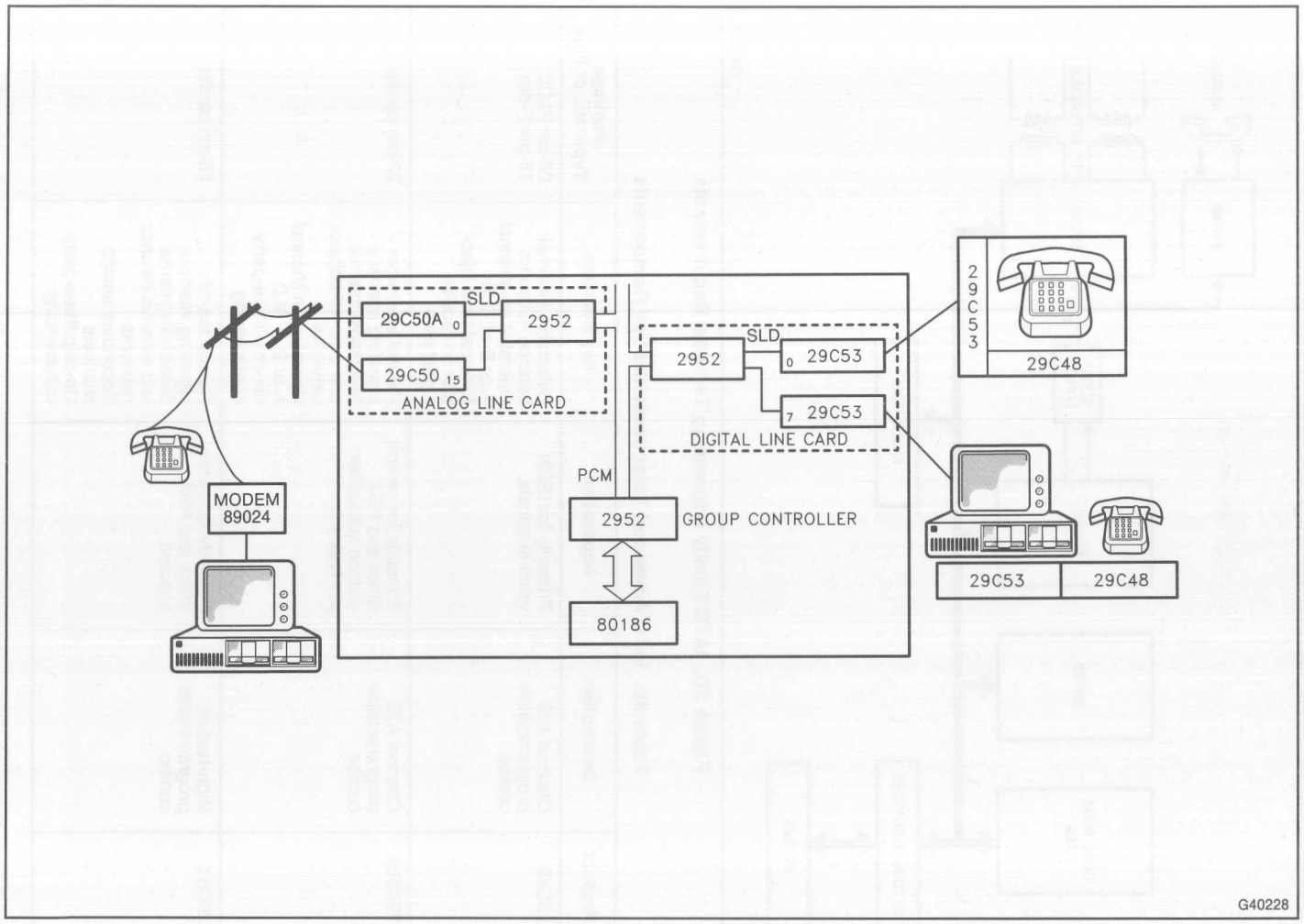


Figure 19. iATC Family Addressing Switching System Requirements

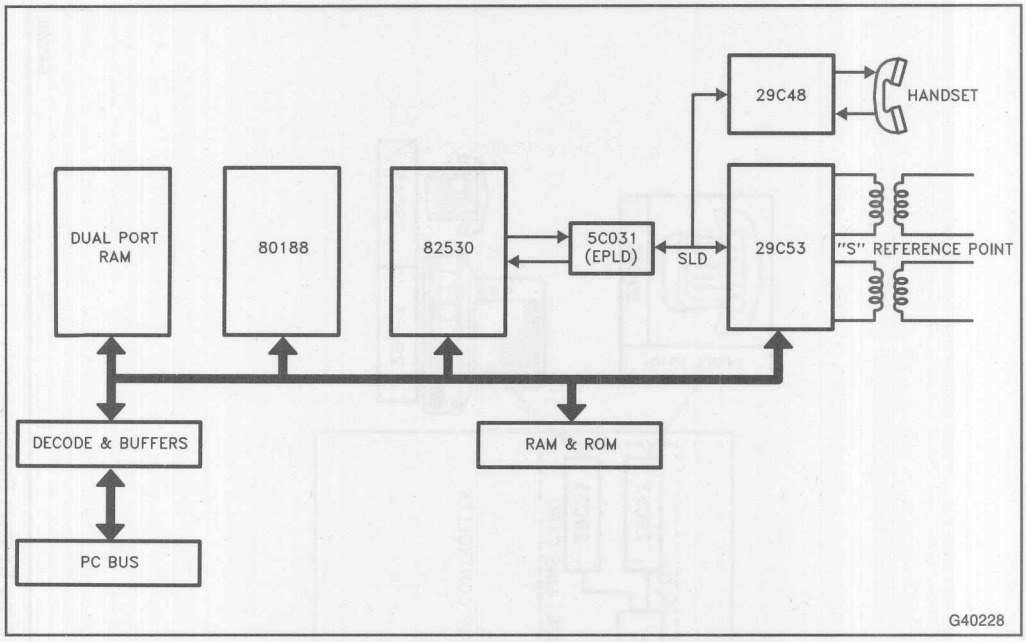


Figure 20. iATC Family Addressing Terminal Requirements

Table 26. iATC Advanced Telecommunication Components

Product	Description	Application	Key Features	Package Type/No. of Pins
29C48	Channel A/B programmable combo	Primarily for ISDN voice terminals.	Selectable external balance networks Operates on channel A or B of SLD External tone injection on receive signal path	28-pin PLCC 18-pin P-dip
29C50A	Channel A/B programmable combo	Primarily for central office and PBX sixteen subscriber per linecard.	Parallel seven-pin signaling interface Selectable internal and external balance networks Operates on channel A or B of SLD On-chip three-party conferencing	22-pin cerdip
29C51	High-feature programmable combo	Primarily for central office and PBX linecard.	Parallel ten-pin signaling interface Selectable internal and external balance networks Secondary analog channels On-chip three-party conferencing	28-pin cerdip

Table 26. iATC Advanced Telecommunication Components (Cont'd.)

Product	Description	Application	Key Features	Package Type/No. of Pins
2952	Linecard controller	Control of subscriber circuits and data routing for analog and digital linecard applications.	Connects up to 16 subscriber channels with up 128 TDM timeslots Can operate standalone under control of HDLC channel Can act as primary station for HDLC control channel Microprocessor port for control of all functions (optional)	40-pin P-dip
29C53	I.430 compatible four-wire transceiver	I.430 compatible PBX linecards, terminals, terminal adaptors, and network terminations.	I.430 compatible S interface Operates at either end of digital loop Bit-level processing of the D-channel HDLC frames	28-pin dip 28-pin PLCC

MODEM PRODUCTS

Intel has introduced a two-chip modem set for highly cost-effective 2400 bps modem designs. The 89024 Intelligent Modem Chip Set supports both CCITT and Bell standards for 300 to 2400 bps full-duplex data communication. In addition to the traditional modulation/demodulation and filtering functions provided by previous generation modem chip sets, the 89024 also has the de facto industry standard AT command set built into the two chips. The high degree of integration provided by the 89024 not only reduces total system cost but also shortens time to market.

In addition to the high degree of integration, the 89024 also provides for easy customization. The 89024 is based on modular firmware architecture. These firmware modules may be modified, or alternatively, custom firmware modules may be added in order to develop a custom modem. Applications might include feature set enhancements and modifications for international market requirements.

Paralleling the growth in the use of personal computers is the need for efficient global data communication. Intel addresses this need with the 89024 Intelligent Modem Chip Set.

In standalone modem applications, the 89024 chip set, along with a telephone line interface (DAA) and RS232 drivers/receivers, represents all the circuitry required for implementing an auto-dial, auto-answer, sync/async, 300 to 2400 bps full-duplex modem.

MODEMS FEATURES

89024 Intelligent Modem Chip Set

Intel's 89024 Intelligent Modem Chip Set is a 2400 bps full duplex modem, providing a complete system in two chips. It comprises an analog front end (89027) for filtering and an

application specific microcontroller (89026) for digital signal processing and command execution. The system conforms to the following CCITT and Bell standards for 2400/1200/600/300 bps modems.

CCITT
- V.22 bis
- V.22 A & B
- V.21

Bell
- 212A
- 103

Main features of the 89024 include:

- Built-in industry standard Hayes command set.
- Software customization of command and feature set.
- Automatic adaptation to remote modem type (CCITT or Bell) and data rate.
- Adaptive equalization.
- Loopback diagnostics.
- On-chip hybrid and billing delay timer.
- Tone and pulse dialing, with automatic selection between the two methods.
- Dial and redial capability.

The following figure shows an implementation of a fully Hayes-compatible standalone 300 to 2400 bps modem using the 89024.

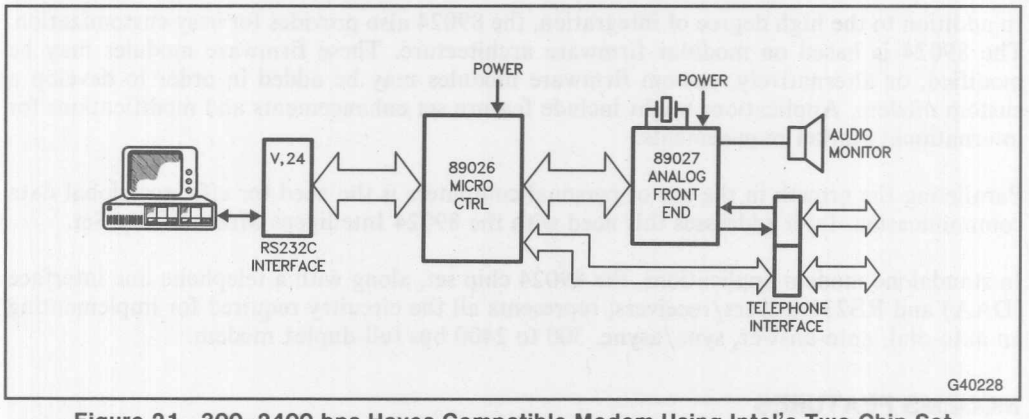


Figure 21. 300–2400 bps Hayes Compatible Modem Using Intel's Two-Chip Set

The high degree of integration and features offered by the 89024 greatly reduces design time and makes it particularly suitable for applications where board space is an important consideration.

MEMORY COMPONENTS

Intel supplies a complete line of cost-effective NMOS and CMOS products in volume production today.

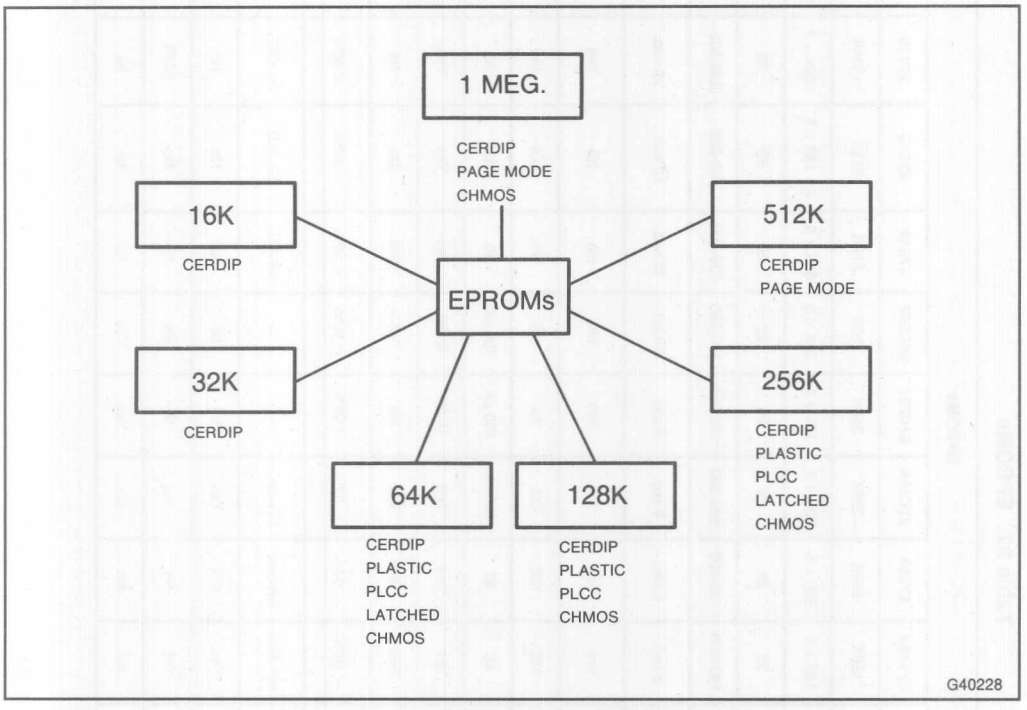


Figure 22. Intel's Expanding EPROM Family

EPROMs

An EPROM, or Erasable Programmable Read-Only Memory, is a non-volatile memory component for program storage and prototyping applications. Intel offers a wide range of EPROM types from 16K to 1M bits. Intel's 1Megabit compacted HMOS* 11-E family provides a range of design options with the byte-wide 27010, page-addressed 27011, and word-wide 27210. Access times are compatible for high-performance microprocessor systems. Intel is moving EPROMs into low-power, high-performance applications with its CHMOS* II-E technology. CMOS versions of the popular 2764, 27128, and 27256 plus address-latched versions for high-integration solutions with microcontrollers are also available.

Intel EPROMs of 64K density and greater feature the int$_e$ligent Programming™ Algorithm, which ensures fast and reliable programming. Intel's Quick-Pulse Programming™ Algorithm cuts programming time down to seconds. (See Table 27.)

Intel supports the rapidly advancing Surface Mount Technology. Intel's line of Plastic Leaded Chip Carriers (PLCC) packages includes 64K, 128K, 256K, and 1 megabit densities.

*CHMOS and HMOS are patented processes of Intel Corp.

Table 27. EPROMs

	EPROMs													
	2732A	**2764A**	**27C64**	**87C64**	**27128A**	**27256**	**27C256**	**87C257**	**68C257**	**27512**	**27513**	**27010**	**27011**	**27210**
Size (Bits)	32K	64K	64K	64K	128K	256K	256K	256K	256K	512K	512K	1024K	1024K	1024K
Organization	4K x 8	8K x 8	8K x 8	8K x 8	16K x 8	32K x 8	32K x 8	32K x 8	32K x 8	64K x 8	4 x 16K x 8	128K x 8	8 x 16K x 8	64K x 16
# of Pins	24	28	28	28	28	28	28	28	28	28	28	32	28	40
Read Access (ns)	200-450	200-300	150-300	150-300	150-300	170-300	120-300	170-250	170-250	200-300	200-300	200-300	200-300	150-250
Programming Time (Typical)*	3.5 min.	1 sec.	1 sec.	1 sec.	3 sec.	6 sec.	6 sec.	6 sec.	6 sec.	12 sec.	12 sec.	20 sec.	20 sec.	10 sec.
Quick-Pulse Programming ALG	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Current (mA) Active	125	75	10	10	100	100	30	15	15	125	125	150	150	150
Current (mA) Standby	35	35	100 μA	100 μA	40	40	100 μA	100 μA	100 μA	40	40	50	50	40
Express Available	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Q188	Q188	Yes	Yes	Yes	Yes	Yes
Military Available	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	No	No	No
Failure Rate/1000 Hrs. @ 55°C (60% UCL)	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%	<.02%
Reliability Data Literature #	RR-35D	RR-35D	RR-35D	RR-35D	RR-35D	RR-35D	RR-35D	—	—	RR-35D	RR-35D	RR-35D	RR-35D	RR-35D
Plastic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
PLCC	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Q288	No	Q288
On-Chip Latch	No	No	No	Yes	No	No	No	Yes	Yes	No	No	No	No	No

*EPROMs per device.

NOTE: Quick-Pulse Programming only on plastic

Megabit EPROM Architecture: Continuity from Today, a Foundation for Tomorrow

Today, as EPROM density has evolved to the one-million-bit density level, semiconductor manufacturers and system designers alike face an architectural and technology turning point. Current EPROM users have adopted the 28-pin site as the standard footprint for devices from 64-kilobit through 512-kilobit densities. To maintain design continuity for customers seeking increased density, this 28-pin site must now be made to accommodate the 1-megabit EPROM. Intel Corporation is committed to maintaining design continuity for its customers, through both its architecture and technology. Intel offers three versions of its 1-megabit EPROM—two that build on the past. All three pave the way to the future.

27011—Page-Addressed (8 x 16K x 8) EPROM

This device enables firmware-intensive designs to be based on 8-bit microprocessors and microcontrollers. Many of these popular processors and controllers are limited in their addressing capabilities and could not otherwise take advantage of 1 megabit of EPROM memory. With this EPROM architecture, new designs based on 8-bit or 16-bit microprocessors can utilize the page-addressing feature, allowing for software upgrades without board redesign. The entire chip looks to the system like eight 128-kilobit EPROMs in the space of one 128-kilobit EPROM. Inventive system designers are finding that advanced software features prolong the usefulness of their 8-bit microprocessor-based system and their software investment. For existing systems constrained to a 28-pin socket, page-addressing provides the only 28-pin solution at the 1-megabit density.

Intel's 27011 one-megabit page-addressed EPROM is configured as eight pages of 16 kilobytes each (8 by 16K by 8). It consumes the least amount of board space among all megabit EPROMs. The by-8 page-addressed architecture is the only no-hardware-change upgrade path, conserving the 28-pin site up to the 32-megabit density.

27210—Word-Wide (64K x 16) EPROM

With its word-wide megabit EPROM pinout, Intel has broken with the past to offer a simplified pinout, one that is a logical extension from the 28-pin and 32-pin EPROM footprints and applicable to both 16-bit and 32-bit microprocessor-based systems. Its word-wide organization makes the 27210 EPROM particularly suited to 16-bit microprocessor applications. All addresses are on one side of the device and data on the other, making this architecture a simple solution that meets the needs of today's advanced microprocessors. This approach preserves performance while simplifying board layout design.

27010—Bytewide (128K x 8) EPROM

The standard-addressed by-8 configuration takes the same step from the 28-pin family as the first 28-pin configuration took from the standard 24-pin site in 1980. It is an extension of the mainstream EPROM market today. Its upward and backward compatibility with other densities gives customers the flexibility to accommodate code overruns or to upgrade their systems to take advantage of the most cost-effective density. For larger, standard-addressed memory arrays of 16-bit or 32-bit words, the smaller 32-pin DIP sockets use less board space than the 40-pin DIP alternatives. This concept allows pin-compatible growth through the 8-megabit density.

Customers can prepare to take advantage of future densities today. Using 32-pin sockets, customers can design with sub-megabit EPROMs today while establishing an upgrade path to megabit EPROMs in the future.

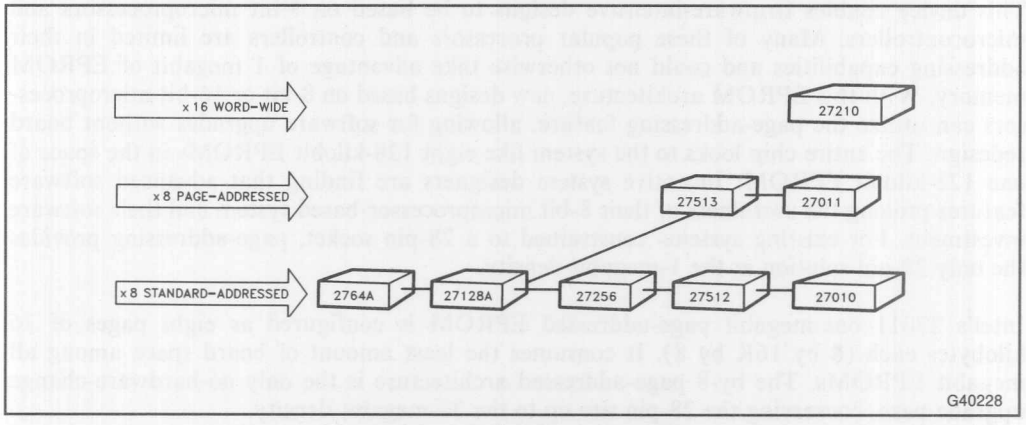


Figure 23. Intel's Pinout Evolution

EMBEDDED CONTROLLERS

Intel offers four basic families of Embedded Controllers: general purpose 8-bit, advanced 8-bit, advanced 16-bit real-time and data control devices. The relative range of application performance is indicated in the diagram below.

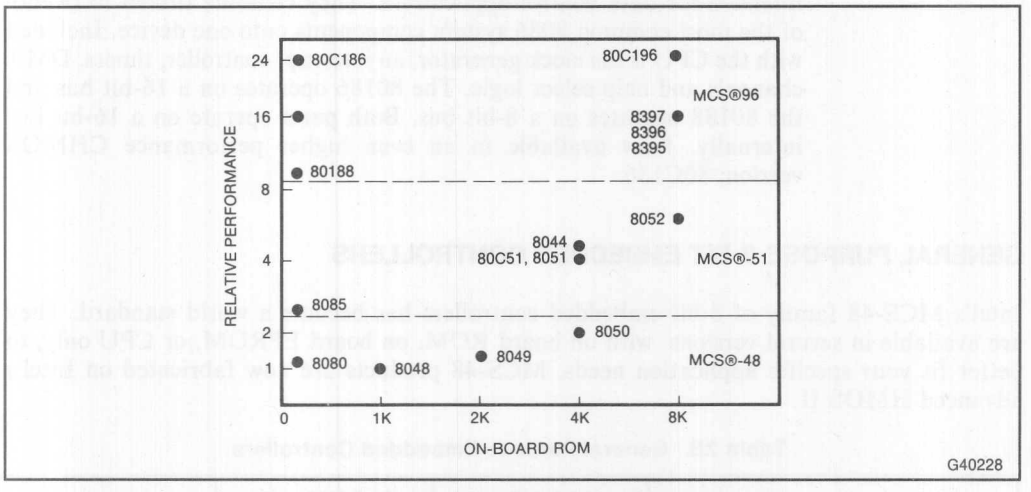


Figure 24. Embedded Controller Performance

BASIC FAMILY CHARACTERISTICS

MCS-48

Designed for general purpose 8-bit control applications.
Average instruction time—2.0 μs.
Maximum addressable code—4K bytes.

MCS-51:

Designed for advanced 8-bit control applications.
Typical instruction cycle time—1.0 μs (byte operations); 0.75 μs for high speed CHMOS.
Hardware multiply and divide (4 μs—byte by byte multiply).
Full-duplex asynchronous serial port.
On-chip Boolean Processor.
Maximum addressable code—64K bytes.

MCS-96:

Designed for computationally intensive real time control applications.
Average instruction time—1.25 μs (word operations).
Hardware multiply and divide (6.5 μs—word by word multiply).
Analog and high-speed programmable digital I/O.
Full-duplex asynchronouos serial port.
Maximum addressable code—64K bytes.
10-bit eight channel A/D converter.
Available in a high-performance CHMOS version; 80C196.

8080/8085: This product line is the industry standard for first-generation 8-bit computing with five second sources and a 9-year track record of production and availability. The 8085A has kept up with advances in silicon technology and is now manufactured as the 8085AH on Intel's state-of-the-art HMOS process.

80186/80188: These parts are highly integrated versions of the 8086 microprocessor, intended for data control applications. They combine fifteen to twenty of the most common 8086 system components onto one device. Included with the CPU is the clock generator, an interrupt controller, timers, DMA channels and chip select logic. The 80186 operates on a 16-bit bus and the 80188 operates on a 8-bit bus. Both parts operate on a 16-bit bus internally. Now available in an even higher performance CHMOS version; 80C186.

GENERAL PURPOSE 8-BIT EMBEDDED CONTROLLERS

Intel's MCS-48 family of 8-bit embedded controllers has become a world standard. They are available in several versions: with on board ROM, on board EPROM, or CPU only, to better fit your specific application needs. MCS-48 products are now fabricated on Intel's advanced HMOS II.

Table 28. General Purpose Embedded Controllers

ROM Version	8048AH	8049AH	8050AH
EPROM Version	8748H	8749H	—
CPU/RAM/I/O	8035AHL	8039AHL	8040AHL
Cycle Time	1.36 μs	1.36 μs	1.36 μs
RAM Memory (Bytes)	64	128	256
Program Memory (Bytes)	1K	2K	4K
I/O Lines	27	27	27
SYNC Mode	Yes	Yes	Yes
Timer-Counter	1	1	1
A/D	—	—	—
Interrupts	2	2	2
Program Limit	4K	4K	4K
Ext. Data Limit (Bytes)	256	256	256
Development Support	See Development Tools and Software sections.		

ADVANCED 8-BIT EMBEDDED CONTROLLERS

Intel's MCS-51 family is an 8-bit high-performance microcontroller. The family architecture is optimized for control-oriented and real-time processing applications. They are available in several versions—with on-board ROM, on-board EPROM, and CPU-only, to better fit your specific application needs. MCS-51 products are available either on Intel's advanced HMOS or CHMOS III processes, offering higher performance and reliability while consuming less power.

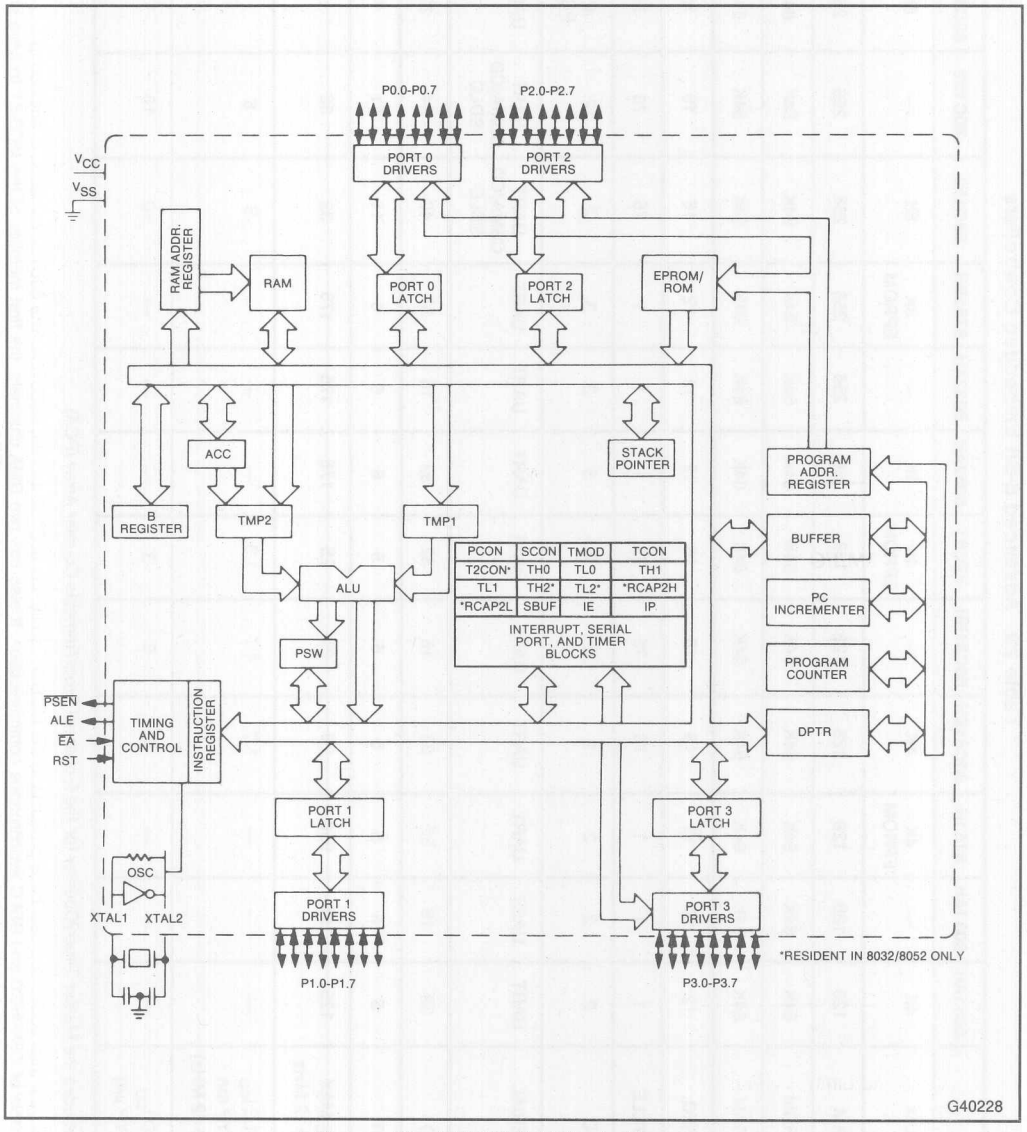


Figure 25. MCS®-51 Block Diagram

Table 29. Advanced 8-Bit Embedded Controllers

	8051AH	8031AH	8751H	80C51BH	80C31BH	87C51	8052AH	8032AH	8752BH	83C152	80C152	83C51FA	80C51FA	87C51FA
ROM	4K	—	4K EPROM	4K	—	4K EPROM	8K	—	8K EPROM	8K	—	8K	—	8K EPROM
RAM	128	128	128	128	128	128	256	256	256	256	256	256	256	256
XROM	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K
XRAM	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K	64K
FREQ.	12	12	12	16	16	16	12	12	12	16	16	16	16	16
CYCLE	1	1	1	75	75	75	1	1	1	75	75	75	75	75
T/C	2	2	2	2	2	2	3	3	3	2	2	4** PCA	4** PCA	4** PCA
SERIAL	UART	UART	UART	UART	UART	UART	UART	UART	UART	UART CSMA/CD SDLC	UART CSMA/CD SDLC	UART	UART	64K
I/O	32	16	32	32	16	32	32	16	32	40	24	32	16	32
INT.	5	5	5	5	5	5	6	6	6	11	11	7	7	7
I_{CC} MAX @ 12 MHz	125	125	250	20	20	25	175	175	175	32	32			24
IDLE I_{CC} (TYP mA @ 12 MHz)	—	—	—	1.7	1.7	1.3	—	—	—	6	6			5
IPD I_{CC} (TYP μA)	—	—	—	5	5	3	—	—	—	10	10			

**Includes the Master Timer/Counter for the 5-channel Programmable Counter Array (PCA).

This year Intel added two new base products to the MCS-51 family, the 80C152 and the 80C51FA. The 80C152 contains, in addition to a UART, a Global Serial Channel capable of CSMA/CD and SDLC synchronous communication. It also has two DMA channels, the first member of the MCS-51 to have such capability. The 80C51FA contains, in addition to the standard timer counters, a programmable counter array (PCA) capable of measuring and generating pulse information on five I/O pins.

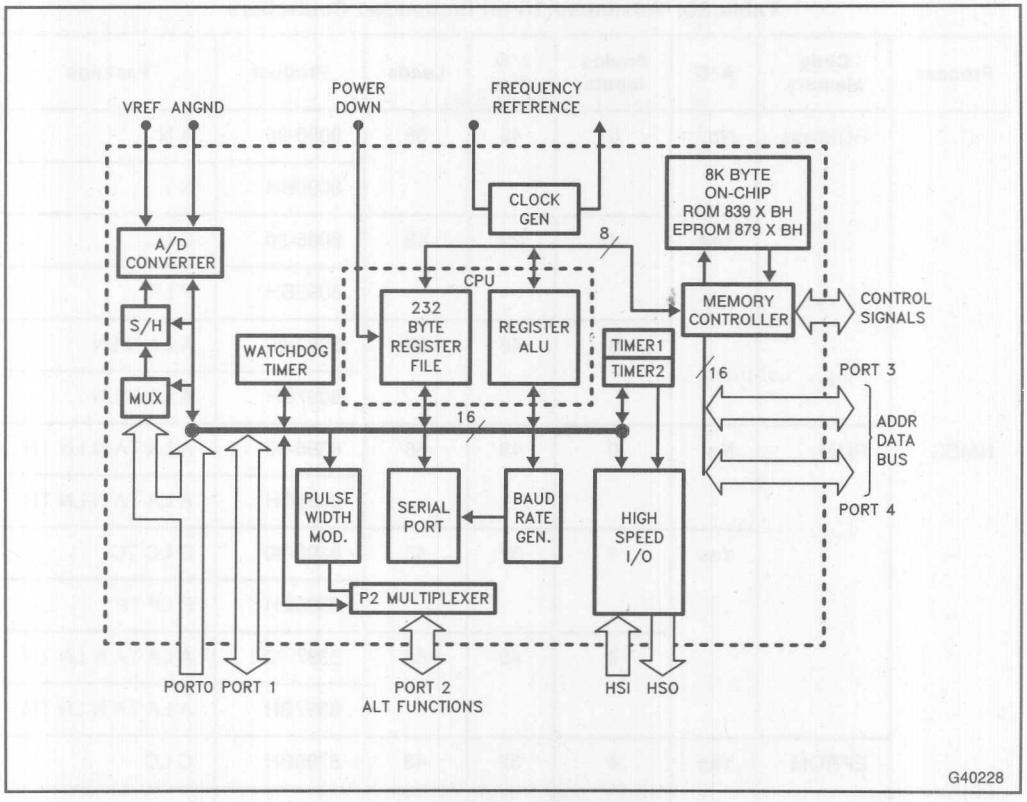


Figure 26. MCS®-96 Block Diagram

ADVANCED 16-BIT EMBEDDED CONTROLLERS

Intel's MCS-96 family is based on the state-of-the-art 8096 architecture. The 8096 provides board-level performance through a wide range of sophisticated I/O facilities and peripherals integrated onto the same piece of silicon with a powerful 16-bit CPU. The integration of these subsystems offers a single-chip solution to many control problems which have previously required multiple-chip solutions. Development support includes high-level language support, assembler support, and emulation hardware support. The list of main features includes:

- 232-byte register file
- Register-to-register architecture
- 10-bit A/D converter with S/H
- Five 8-bit I/O ports
- Twenty interrupt sources
- Pulse-width modulated output
- Dedicated baud-rate generator
- Run-time programmable EPROM
- High-speed I/O subsystem
- Full-duplex serial port
- 6.25 μs 16 x 16 multiply
- 6.25 μs 32/16 divide
- 16-bit watchdog timer
- Four 16-bit software timers
- Two 16-bit counter/timers
- ROM/EPROM security
- Dynamically reconfigurable 8-bit or 16-bit bus width

Table 30. Advanced 16-Bit Embedded Controllers

Process	Code Memory	A/D	Analog Inputs	I/O Pins	Leads	Product	Package
NMOS	ROMless	No	0	48	68	8096-90	A N
						8096BH	N
		Yes	4	32	48	8095-90	C LC
						8095BH	P LP
			8	48	68	8097-90	A LA N LN
						8097BH	A LA N LN
	ROM	No	0	48	68	8396-90	A LA TA N LN TN
						8396BH	A LA TA N LN TN
		Yes	4	32	48	8395-90	C LC TC
						8395BH	P LP TP
			8	48	68	8397-90	A LA TA N LN TN
						8397BH	A LA TA N LN TN
	EPROM	Yes	4	32	48	8795BH	C LC
			8	48	68	8797BH	A LA R LR
CHMOS	ROMless	Yes	8	48	68	80C196KA	A N L
	ROM	Yes	8	48	68	83C196KB	A N L
	EPROM	Yes	8	48	68	87C196KB	A N L

In 1987, Intel added a new series to the MCS-96 family, the 80C196KA. This part is implemented on a high-performance CMOS process and offers significantly more performance and reduced power levels. The design also includes many detail improvements while still retaining compatibility with the NMOS versions of the MCS-96 family.

In 1987, Intel introduced CMOS versions of the 80188 and 80186. In addition to lower power, these parts offer increased performance (16 MHz vs 10 MHz for the NMOS parts) and two new features: power save and DRAM refresh.

80186 HIGH INTEGRATION EMBEDDED CONTROLLER

The 80186 family of embedded controllers was designed to bring the 8086 architecture to embedded control applications. Six of the most often used functions of an 8086 system have been integrated onto a single chip. Along with higher integration, the 80186 offers higher performance than the standard 8086 via detailed improvements to the design. The 80186 family consists of two embedded controllers: the 80186 and the 80188. See Table 2 for additional specifications. These processors have identical capabilities, except that the 80186 operates on a 16-bit bus while the 80188 operates on an 8-bit bus. The 80186 offers higher system performance with its 16-bit bus; the 80188 offers lower system cost with its 8-bit bus. Both controllers operate internally with a 16-bit bus and generate a 20-bit address to give a total address space of 1 Megabyte. Now available in a CHMOS, fully compatible version; the 80C196.

The major features of the 80186 and 80188 include:

- Two-Channel DMA (Direct Memory Access) unit
- Three 16-bit timer/counters
- Interrupt controller
- Clock generator
- Chip select logic
- Ready control logic
- CHMOS technology

Unlike the other embedded control products, the 80186 is intended for applications which need relatively large amounts of program storage and require large and complex data structures. Since it is impractical to integrate the amount of memory required for typical applications onto the processor chip, no attempt is made to incorporate memory on board.

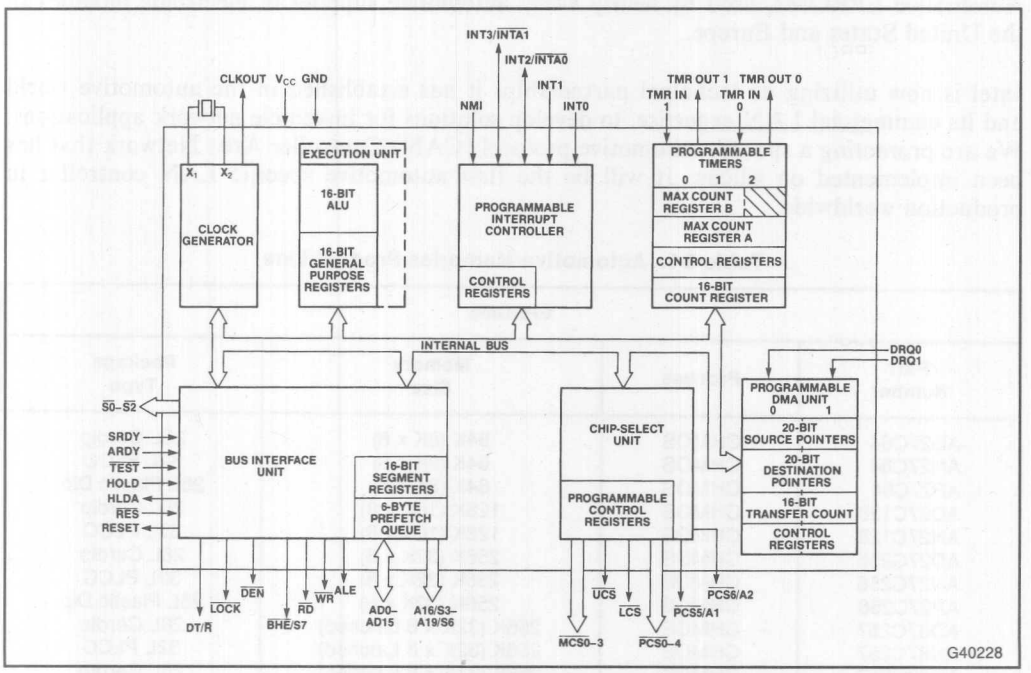


Figure 27. 80186 Block Diagram

AUTOMOTIVE

Intel has been serving in the automotive market since 1978. By working closely with major automotive partners/trendsetters, we are developing the automotive-specific expertise that has resulted in very successful leadership products:

MCS-51: High-performance 8-bit microcontroller family, adapted to high-speed real-time control. Currently used in engine control, anti-lock braking systems, cruise control/drive-by-wire, instrumentation, safety belt, and air bags.

MCS-96: First high-performance 16-bit microcontroller family, optimized for computationally intensive automotive applications. Products of the family are now in production or under development in engine control, anti-lock/traction control braking systems, instrumentation, climate control, active suspension designs, and electric steering devices.

EPROMs: In addition to offering a complete line of JEDEC automotive specific EPROMs from 64K-256K bit density, Intel now offers high-integration EPROMs with on-chip latches for a "no-glue" interface to Intel and 68XXX family microcontrollers.

Today, Intel's architectures are well accepted in the anti-lock/anti-skid brake and engine control applications with 8- and 16-bit microcontrollers. Intel is also the market leader in Automotive EPROMs, used by nearly every automotive supplier of electronic modules in the United States and Europe.

Intel is now utilizing its technical partnerships it has established in the automotive world and its commercial LAN expertise, to develop solutions for in-vehicle network applications: We are promoting a specific automotive protocol (CAN) Controller Area Network that has been implemented on silicon. It will be the first automotive specific LAN controller in production worldwide.

Table 31. Automotive Memories Product Line

EPROMs			
Part Number	**Process**	**Memory Size**	**Package Type**
AD27C64	CHMOS	64K (8K x 8)	28L Cerdip
AN27C64	CHMOS	64K (8K x 8)	32L PLCC
AP27C64	CHMOS	64K (8K x 8)	28L Plastic Dip
AD27C128	CHMOS	128K (16K x 8)	28L Cerdip
AN27C128	CHMOS	128K (16K x 8)	32L PLCC
AD27C256	CHMOS	256K (32K x 8)	28L Cerdip
AN27C256	CHMOS	256K (32K x 8)	32L PLCC
AP27C256	CHMOS	256K (32K x 8)	28L Plastic Dip
AD87C257	CHMOS	256K (32K x 8 Latched)	28L Cerdip
AN87C257	CHMOS	256K (32K x 8 Latched)	32L PLCC
AD68C257	CHMOS	256K (32K x 8 Latched)	28L Cerdip
AN68C257	CHMOS	256K (32K x 8 Latched)	32L PLCC

Table 32. Automotive Embedded Controller Product Line

Part	Process	Features	Package Type
A8051	HMOS	8-bit, 4K ROM, 128 Bytes RAM	40-Pin Plastic DIP, 44-Pin PLCC
A8031	HMOS	8-bit, 128 Bytes RAM	40-Pin Plastic DIP, 44-Pin PLCC
A8751	HMOS	8-bit, 4K EPROM, 128 Bytes RAM	40-Pin CERDIP 44-Pin LCC
A8052	HMOS	8-bit, 8K ROM, 256 Bytes RAM	40-Pin Plastic DIP
A8032	HMOS	8-bit, 256 Bytes RAM	40-Pin Plastic Dip
A80C51	CHMOS	8-bit, 4K ROM, 128 Bytes RAM	40-Pin Plastic DIP, 44-Pin PLCC
A80C31	CHMOS	8-bit, 128 Bytes RAM	40-Pin Plastic DIP, 44-Pin PLCC
A87C51	CHMOS	8-bit, 4K EPROM, 128 Bytes RAM	40-Pin CERDIP 44-Pin LCC
A80C51FA	CHMOS	8-bit, 256 Bytes RAM, 5 PCAs	40-Pin Plastic Dip 44-Pin PLCC
A83C51FA	CHMOS	8-bit, 8K ROM, 256 Bytes RAM, 5 PCAs	40-Pin Plastic Dip 44-Pin PLCC
A87C51FA	CHMOS	8-bit, 8K EPROM, 256 Bytes RAM, 5 PCAs	40-Pin CERDIP 44-Pin PLCC
A8397	HMOS	16-bit, 8K ROM, 232 Bytes RAM, A/D	68-Pin PLCC Plastic Flatpack
A8097	HMOS	16-bit, 232 Bytes RAM, A/D	68-Pin PLCC Plastic Flatpack
A8797	HMOS	16-bit, 8K EPROM, 232 Bytes RAM, A/D	68-Pin LCC 68-Pin Ceramic Flatpack
A8096	HMOS	16-bit, 232 Bytes RAM	68-Pin PLCC Plastic Flatpack
A8396	HMOS	16-bit, 8K ROM, 232 Bytes RAM	68-Pin PLCC Plastic Flatpack
A8796	HMOS	16-bit, 8K EPROM, 232 Bytes RAM	68-Pin LCC 68-Pin Ceramic Flatpack
A80C196KA	CHMOS	16-bit, 232 Bytes RAM, A/D	68-Pin PLCC, PFP
A87C196KB*	CHMOS	16-bit, 8K EPROM, 232 Bytes RAM, A/D	68-Pin LCC 68-Pin Ceramic Flatpack

*Available in Q3'88.

MILITARY PRODUCTS

The components included in Intel's Military product family are summarized in the table below. A more complete description of each generic device can be found in this Guide by referring to the appropriate component section or by using the Alphanumeric Index located in the front of this Guide.

Table 33. Military Products

Type	Product	Description	Maximum Clock Speed	Package Type			
				DIP	LCC	PGA	CQ
Embedded Controller	M8031AH	High-Performance 8-Bit Single-Chip Computer without ROM, 128 × 8-Bit RAM, Boolean Processor.	12 MHz	X			
	M80C31BH	High-Performance 8-Bit Single-Chip Computer without ROM, 128 × 8-Bit RAM, Low Power CHMOS, Power-Down and Idle Modes.	12 MHz	X	X		2
	M8035AHL	8-Bit Single-Chip Computer without ROM, 64 × 8-Bit RAM, Power-Down Mode.	11 MHz	X			
	M8048AH	8-Bit Single-Chip Computer, 1K × 8-Bit Mask Programmable ROM, 64 × 8-Bit RAM, Power-Down Mode.	11 MHz	X			
	M8051AH	High-Performance 8-Bit Single-Chip Computer, 4K × 8-Bit Mask Programmable ROM, 128 × 8-Bit RAM, Boolean Processor.	12 MHz	X			
	M80C51BH	High-Performance 8-Bit Single-Chip Computer, 4K × 8-Bit Mask Programmable ROM, 128 × 8-Bit RAM, Low Power CHMOS, Power-Down and Idle Modes.	12 MHz	X	X		
	M8085AH	8-Bit Parallel CPU, 1.3 μsec Instruction Cycle, On-Chip Clock Generator and System Controller, DESC SID 7901001QX.	3 MHz	X			
	M8097	High-Performance 16-Bit Embedded Controller with A/D, PWM Output, HSIO, 232 Bytes RAM, 40 I/O Lines, Watch Dog Timer.	12 MHz			X	X
	M80186	High-Integration 16-Bit Embedded Controller.	6, 8 MHz			X	X
	M8397	High-Performance 16-Bit Embedded Controller with A/D, PWM Output, HSIO, 232 Bytes RAM, 40 I/O Lines, Watch Dog Timer, plus 8K × 8-Bit ROM.	12 MHz			X	X

Table 33. Military Products (Cont'd.)

Type	Product	Description	Maximum Clock Speed	Package Type			
				DIP	LCC	PGA	CQ
Embedded Controller (Cont'd.)	M8748H	8-Bit Single-Chip Computer with 1K × 8-Bit EPROM, 64 × 8-Bit RAM.	11 MHz	X			
	M8751H	High-Performance 8-Bit Single-Chip Computer with 4K × 8-Bit EPROM, 128 × 8-Bit RAM, Boolean Processor.	8 MHz	X	X		
	M87C51	High-Performance 8-Bit Single Chip Computer with 4K × 8-Bit EPROM, 128 × 8-Bit RAM, Low Power CHMOS, Power-Down and Idle Modes.	12 MHz	X			
	M8797	High-Performance 16-Bit Embedded Controller with A/D, PWM Output, HSIO, 232 Bytes RAM, 40 I/O Lines, Watch Dog Timer, Plus 8K × 8-Bit EPROM.	12 MHz			X	X
Microprocessor	J8086	16-Bit Microprocessor, (JAN) M38510/53001BQX.	5 MHz	X			
	M8086	16-Bit Microprocessor.	5 MHz 8 MHz	X	X		
	M8087	Numeric Data Processor, Math and Floating Point Hardware for Host M8086 and M8088.	5 MHz	X			
	M8088	High-Performance 8-Bit Microprocessor, 16-Bit Internal Architecture.	5 MHz	X			
	M80286	High-Performance 16-Bit Microprocessor with Memory Management and Protection.	6, 8, 10 MHz			X	X
	M80C286	CHMOS High-Performance 16-Bit Microprocessor with Memory Management and Protection.	12.5 MHz			X	
	M80287	Numeric Processor Extension, Math and Floating Point Hardware Support for Host M80286.	8, 10 MHz	X			
	M80C287	CHMOS Numeric Processor Extension, Math and Floating Point Hardware Support for Host M80C286.	12.5 MHz	X			
	M80C86	16-Bit CHMOS Microprocessor.	5, 8 MHz	X			
	M80386	32-Bit CHMOS Microprocessor.	12.5, 16 MHz			X	X
	M80387	Numeric Processor for M80386.	12.5, 16 MHz			X	

Table 33. Military Products (Cont'd.)

Type	Product	Description	Maximum Clock Speed	Package Type			
				DIP	LCC	PGA	CQ
Support Product	M8243	I/O Expander for M8035AHL/ M8048AH/M8748H.		X			
	M8282	8-Bit Parallel Address/Data Latch.		X	X		
	M8283	8-Bit Parallel Inverting Address/Data Latch.		X	X		
	M8284A	Single-Chip Clock Generator and Driver for M8086, M8088, M8087 and M8089.	8 MHz	X	X		
	M8266	8-Bit Parallel Address/Data Bus Transceiver.		X	X		
	M8287	8-Bit Parallel Inverting Address/Data Bus Transceiver.		X	X		
	M8288	Bus Controller for M8086, M8088 and M8089, Provides Command and Control Timing Generation.	8 MHz	X	X		
	M82C88	Bus Controller for M80C86.	8 MHz	X			
	M8289	Bus Arbiter for M8086, M8088 and M8089 System Buses.	8 MHz	X	X		
	M82188	Integrated Bus Controller for use with M8086, M8088, and M80186-6 Systems.	8 MHz	X			
	M82C84A5	CHMOS Clock Generator and Driver for M80C86.	5 MHz				
	M82C88	CHMOS Bus Controller for M80C88.	5 MHz	X			
	M82284	Clock Generator and Ready Interface for M80286.	6, 8 MHz	X			
	M82288	Bus Controller for M80286.	6, 8 MHz	X			
	M82289	Bus Arbiter for M80286.	6, 8 MHz	X			
	M82384	Clock Generator and Ready Interface for M80386.	12.5, 16 MHz	X			
	M82258	Advanced DMA Controller for 80286.		X			
Controller	M8257	Four-Channel Programmable DMA (Direct Memory Access) Controller for M8080A and M8085AH.	3 MHz	X			
	M8259A	Programmable Interrupt Controller, Handles Up to Eight-Vectored Priority Interrupts.		X	X		
Peripheral	M8155	256 × 8-Bit Static RAM with 22 Programmable I/O Ports, Binary Timer/Counter.		X			
	M8185	1K × 8-Bit Static RAM with Internal Address Latch.		X			
	M8231A	Arithmetic Processing Unit, High-Performance Fixed and Floating Point Arithmetic and Floating Point.	4 MHz	X	X		

Table 33. Military Products (Cont'd.)

Type	Product	Description	Maximum Clock Speed	Package Type			
				DIP	LCC	PGA	CQ
Peripheral (Cont'd.)	M8251A	Programmable Communication Interface (USART).	3 MHz (19.2 Kbps)	X	X		
	M82510	CHMOS Programmable Communication Interface (UART).	4 MHz (288 Kbps)	X			
	M8254	Programmable Interval Timer, Three Independent 16-Bit Counters.	DC to 8 MHz	X	X		
	M8255A	Programmable Peripheral Interface, Twenty-four Programmable I/O Ports.		X	X		
	M8274	Multi-Protocol Serial Controller.	4 MHz (880 Kbps)	X			
	M82720	Graphics Display Controller.	4 MHz	X			
	M82786	CHMOS Graphics Coprocessor, Bit Mapped, 2.5M pixels/second.	25 MHz			X	
	M8744H	High-Performance 8-Bit Microcontroller with On-Chip Serial Communication Processor.	10 MHz (2.4 Mbps)	X			
	M82C54	CHMOS, Three 16-Bit Counters 8254 Compatible.	8 MHz	X			
	M82C55	CHMOS, Twenty-four TTL-Compatible Parallel I/O Lines.		X			
	M82553	CHMOS, Mil STD-1553 Protocol Mgt. Unit.	12 MHz			X	
EPROM	M2716M	2K × 8-Bit	tCE = 450	X			
	M2732A	4K × 8-Bit	tCE = 250-450	X			
	M2764A	8K × 8-Bit	tCE = 250-350	X	X		
	M27128A	16K × 8-Bit	tCE= 110-300	X			
	M27256	32K × 8-Bit	tCE = 170-350	X	X		
	M27512	64K × 8-Bit	tCE = 200-350	X			
	M27011	16K × 8 × 8 Paged	tCE = 250-300	X			
	M27210	64K × 16-Bit	tCE = 200-250	X			
	M27C64	8K × 8 CHMOS	tCE = 200-350	X	X		
	M27C256	32K × 8 CHMOS	tCE = 200-250	X	X		
	J27256	32K × 8 M38510/224	tCE = 250	X			

Table 33. Military Products (Cont'd.)

Type	Product	Description	Maximum Clock Speed	Package Type			
				DIP	LCC	PGA	CQ
SRAM	M2114A	1K × 4-Bit	tAA = 150-250	X			
	J2147H	4K × 1-Bit	tAA = 85				
		M38510/23801 BVX	tAA = 85				
		M38510/23803 BVX	tAA = 70	X			
		M38510/23805 BVX	tAA = 55	X			
		M38510/23807 BVX	tAA = 45	X			
	M2147H	4K × 1-Bit	tAA = 45-85	X			
	J2148H	1K × 4-Bit	tAA = 70	X			
		M38510/23806 BVX					
	M2148H	1K × 4-Bit	tAA = 55-70	X			
	M51C67	16K × 1-Bit CHMOS	tAA = 35-55	X			
	M51C68	4K × 4-Bit CHMOS	tAA = 35-70	X			
	M51C98	16K × 4-Bit CHMOS	tAA = 35-55	X			
EPLD	M5C060	600 Gate Erasable Program Logic	tCE = 45-55	X			
	M5C180	1800 Gate	tCE = 45-55			X	

EXPRESS (EXTENDED RELIABILITY)

EXPRESS is a service program that allows users of Intel IC components to tailor the products' electrical test flow to their specific application requirements. The test flows are designed to suit a broad range of system and production requirements.

The EXPRESS program offers users of Intel microcomputers, RAMs, EPROMs, and peripheral component families products that are screened to operate within two industry-standard temperature ranges, each with the option of 168 ± 8 hours of dynamic burn-in (equivalent to MIL-STD-883B, Method 1015). All Intel processing technologies are included. New products will enter the program as they become available.

The key to using EXPRESS is the generic matrix. You can, by specifying a two-letter prefix, select the test flow your product requires including its operating temperature range and package type. The two operating temperature ranges are: Commercial (0°C to 70°C) and Extended (−40°C to 85°C). Products are available in both hermetic ceramic and molded plastic packages that meet these temperature specifications. Adding the option of burn-in creates the versatile EXPRESS matrix.

Table 34. EXPRESS Matrix

Temperature Range	Burn-In Hours	
	(None)	(168 ± 8)
Commercial 0°C to 70°C	Standard	Q
Extended −40°C to 85°C	T	L

Table 35. EXPRESS Prefix Definitions

Standard	High-Quality Standard Products
Q	Standard product with burn-in and 100% units post burn-in electrical screening to Commercial temperature range.
T	Standard product with extended temperature screening.
L	Standard product with burn-in and 100% unit post burn-in electrical screening to extended temperature range.

The EXPRESS test flow first subjects 100% of all products to a stringent class electrical examination. Complete DC, AC, and functional parameters are tested at operating guard band temperature(s) for compliance to published specifications. Then at your option, the product undergoes 168 + 8 hours of dynamic burn-in at 125°C. Post-burn-in screening features a 100% unit electrical retest of DC, AC, and functional parameters to guarantee the product's performance over its designated operating temperature range.

Both these product flows, independent of package type, then receive sample screening for electrical and visual parameters by Final Quality Assurance to 0.1% AQL. These standards are periodically reviewed, and tightened according to Intel's corporate quality goals.

Table 36. EXPRESS Products

Type	Product	Description	Q	T	L
Embedded Controller	8031AH	8-Bit Single Chip Computer, without Rom, Boolean Processor, 128 × 8-Bit RAM.	X	X	X
	8032AH	8-Bit Single Chip computer, without ROM, Boolean Processor, 256 × 8-Bit RAM.	X	X	X
	8035AHL	8-Bit Single Chip Computer, without ROM, 64 × 8-Bit RAM.	X	X	X
	8039AHL	8-Bit Single Chip Computer, without ROM, 128 × 8-Bit RAM.	X	X	X
	8040AHL	8-Bit Single Chip Computer, without ROM, 256 × 8-Bit RAM.	X	X	X
	8048AH	8-Bit Single Chip Computer, 1K × 8-Bit ROM, 64 × 8-Bit RAM.	X	X	X
	8049AH	8-Bit Single Chip Computer, 2K × 8-Bit ROM, 128 × 8-Bit RAM.	X	X	X
	8050AH	8-Bit Single Chip Computer, 4K × 8-Bit ROM, 256 × 8-Bit RAM.	X	X	X
	8051AH	8-Bit Single Chip Computer, 4K × 8-Bit ROM, 128 × 8-Bit RAM, Boolean Processor.	X	X	X
	8052AH	8-Bit Single Chip Computer, 8K × 8-Bit ROM, Boolean Processor, 256 × 8-Bit RAM.	X	X	X
	8085AH	8-Bit HMOS CPU.	X	X	X
	80186	Highly Integrated 16-Bit CPU.	X	X	
	80188	Highly Integrated 8-Bit CPU with 16-Bit Internal Architecture.	X	X	
	8748H	8-Bit Single Chip Computer, 1K × 8-Bit EPROM, 64 × 8-Bit RAM.	X	X	X
	8749H	8-Bit Single Chip Computer, 2K × 8-Bit EPROM, 128 × 8-Bit RAM.	X	X	X
	8243	I/O Expander for Embedded Controllers.	X	X	X
Microprocessor	8086	16-Bit HMOS CPU	X	X	X
	8087	Numeric Data Processor	X	X	X
	8088	8-Bit HMOS CPU, 16-Bit Internal Architecture	X	X	X
	8089	8 × 16-Bit I/O Processor	X	X	X
	80286	High-Performance, Multitasking 16-Bit CPU	X		
	80287	High-Performance Numeric Data Processor	X		
Support Product	8282	Parallel Bus Latch	X	X	X
	8283	Parallel Bus Latch	X	X	X
	8264A	Clock Generator for 8086, 8088	X	X	X
	82284	Clock Generator for 80286	X		
	8286	Parallel Bus Transceiver	X	X	X
	8287	Parallel Bus Transceiver	X	X	X
	8288	Bus Controller for 8086, 8088	X	X	X
	82288	Bus Controller for 80286	X		
	8289	Bus Arbiter for 8086, 8088	X		
	8755A	2K × 8-Bit EPROM with I/O Ports	X	X	X

Table 36. EXPRESS Products (Cont'd.)

Type	Product	Description	Q	T	L
Controller	8237A	High Performance Programmable DMA Controller.	X		
	8257	Programmable DMA Controller.	X		
	8259A	Programmable Interrupt-Controller.	X	X	X
Peripheral	8042	Universal Peripheral Interface 8-Bit Microcomputer.			X
	8044	High-Performance 8-Bit Microcontroller with 4K Bytes of On-Chip ROM.	X	X	X
	8155H	256 × 8-Bit RAM, I/O Ports, Counter.	X	X	X
	8156H	256 × 8-Bit RAM, I/O Ports, Counter.	X		
	8203	64K Dram Controller.	X		
	8251A	Programmable Communication Interface.	X	X	X
	8253	Programmable Interval Timer, 3 MHz.	X	X	X
	82530	Serial Communications Controller.	X	X	X
	82530-6	Serial Communications Controller.	X	X	X
	8254	Programmable Interval Timer, 8 MHz.	X	X	X
	8255A	Programmable-Peripheral Interface.	X	X	X
	8272A	Single/Double Density Floppy Disk Controller.	X		
	8274	Multi-Protocol Serial Controller.	X		
	8279	Programmable Keyboard/Display Interface.	X		
	8291A	GPIB Talker/Listener.	X		
	8292	GPIB Controller.	X		
	8293	GPIB Transceiver.	X		
	8344	High-Performance 8-Bit Microcontroller with On-Chip Serial Communication Processor.	X	X	X
	8741A	Universal Peripheral Interface, 64 × 8-Bit RAM.	X		
	8742	Universal Programmable Interface, 128 × 8-Bit RAM.	X		
EPROM	2732A	4K × 8-Bit	X	X	X
	2764A	8K × 8-Bit	X	X	X
	27128A	16K × 8-Bit	X	X	X
	27256	32K × 8-Bit	X	X	X
	27512	64K × 8-Bit	X	X	X
	27513	4 × 16K × 8-Bit, Page Addressed	X	X	X
	27010	128K × 8-Bit	X	X	X
	27011	8K × 16-Bit × 8-Bit, Page Addressed	X	X	X
	27210	64K × 16-Bit	X	X	X
	27C64	8K × 8-Bit	X	X	X
	87C64	8K × 8-Bit, Latched	X	X	X
	27C128	16K × 16-Bit	X	X	X
	27C256	32K × 8-Bit	X	X	X
	87C257	32K × 8-Bit, Latched	X	X	X
	68C257	32K × 8-Bit, Latched	X	X	X
Static RAM	2114A	1K × 4-Bit, Three State	X	X	X
	2115A	1K × 1-Bit, Open Collector	X		
	2125A	1K × 1-Bit, Three State	X		
	2147H	4K × 1-Bit, Three State	X	X	X
	2148H	1K × 4-Bit, Three State	X	X	x
	2149H	1K × 4-Bit, Three State	X		

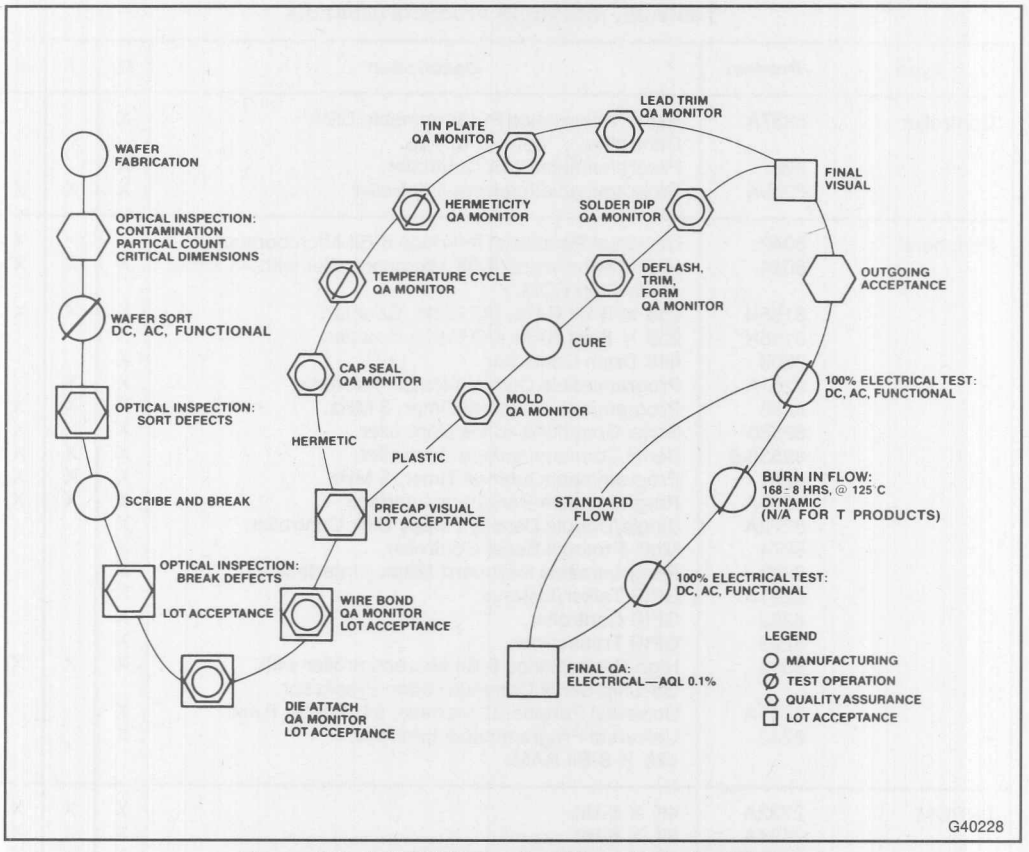


Figure 28. EXPRESS Product Manufacturing Flow

APPLICATION SPECIFIC INTEGRATED CIRCUITS (ASIC)

One of the most important recent developments in the semiconductor industry has been the emergence of application specific integrated circuits (ASIC) as a significant factor in the marketplace. While the first two decades have been dominated by standard, mass produced chips, ASICs—custom developed for specific users and systems—are increasingly seen as a preferred alternative.

ERASABLE PROGRAMMABLE LOGIC DEVICES (EPLDs)

The H-Series family of EPLDs contains devices ranging in complexity from 300 to 1,800 gates, Hard Macro Logic devices, and a new family of flexible architecture EPLDs. EPLDs are manufactured as unprogrammed CHMOS large-scale integration logic devices that a user customizes through programming on a logic development system. The iPLDS II (Intel Programmable Logic Development System) provides all the tools needed for creating a logic design, optimizing and custom-fitting the design to a particular EPLD device, and then programming and verifying the EPLD.

GATE ARRAY INTEGRATED CIRCUITS

Intel's ASIC products include two families of high-performance gate arrays, based on Intel's 1.5 micron dual-level metal CHMOS III process and ranging in complexity from roughly 2,500 to 19,000 equivalent gates. One family consists of conventional gate arrays, while the second is a composite array family featuring user-definable RAM configuration and more diverse functionality.

CELL-BASED INTEGRATED CIRCUITS

Intel's advanced cell-based family of integrated circuits is based on a comprehensive set of pre-designed, fully characterized functions for the integration of system logic into high-performance, cost-effective semi-custom devices. The cell-based library contains over 150 logic, I/O, and special functions cells. Also available are VLSI cells such as the 80C51BH 8-bit microcontroller and cell equivalents of Intel microprocessor peripheral functions. The cell-based ICs are manufactured using Intel's 1.5 micron CMOS double layer metal process, the same process used for standard components such as the 80386.

INTEL DESIGN ENVIRONMENT (IDE)

The Intel Design Environment brings a number of unprecedented capabilities to the ASIC market. IDE includes all the products, design services, and manufacturing expertise required to design and produce a complete line of ASIC products. Intel has equal strengths in all three major ASIC technologies—programmable logic, gate array, and cell-based integrated circuits.

Intel's ASIC CAE tools comprise a selection of the best the industry has to offer. Supported by a range of industry-standard hardware platforms, the ASIC libraries are available for use at Intel ASIC design centers or at customer sites, running on customer-owned platforms.

H-SERIES EPLDs (Erasable Programmable Logic Devices) AND THE iPLDS II (Intel Programmable Logic Development System)

Intel's H-Series EPLDs consist of devices ranging from 300 to 1,800 gates, Hard Macro Logic devices for application specific designs, and a new family of flexible architecture devices. Based on reliable and flexible EPROM technology, these devices enable users to develop and mass produce a custom circuit using standard, off the shelf components. EPLDs are supported with an advanced set of development tools hosted on the PC. The iPLDS II is an easy to use system for creating a logic design, optimizing and "custom fitting" the design to a particular EPLD, and programming and verifying the device. The iPLDS II development kit includes a plug-in PC card, a programming module, and complete documentation including design examples. Schematic Entry is also available with the Schema II-PLD software package allowing engineers to use TTL Macro functions, create their own Macro Library, and print Schematic Drawings of their design. The EPLDs are manufactured using Intel's CHMOS II-E process technology to assure systems designers high performance, low power devices, maintaining Intel's strict commitment to the highest quality and reliability standards.

Product Highlights

H-Series CMOS EPLDs — Erasable Programmable Logic Devices

- Low Power 50 mW Typical Standby Power
- 300-1,800 Gate Complexity
- Application Specific Bus Interface Controller
- Flexible P-Term Allocation
- Advanced Architectures; D, T, RS, and JK Registers; Asynchronous Clocks
- Programmable Security Bit
- High Performance: 35 ns Combinatorial Device Speeds, 30 MHz Clock Rates
- 100% Generic Testability

iPLDS II — Intel Programmable Logic Development System

- Includes Software and Programming Hardware
- Low Cost
- Able to Minimize and Compile Designs for Complex Devices (1,800 Gate EPLDs)
- Interfaces to PC-Based Schematic Entry Tools: Schema II-PLD, PC-CAPs (P-CAD), DASH4 (FutureNet)
- Generates Output in Standard JEDEC file Format
- Provides Programming Support for other Intel Products (e.g., EPROMs, Microcontrollers)

Design Center Support Services

- Hotline Support for Technical Questions—Contact your Local Sales Office for the Number
- Twenty-Four Hour Bulletin Board Service 1-916-351-2717 provides Design examples, Utility Programs, and Upload/Download Capability for Transferring Design Files
- Design Assistance and Recommendations—Contact your Local Sales Office

GATE ARRAYS

Intel's VLSI experience, coupled with an established gate array capability, gives system designers a bridge between standard architectures and semi-custom solutions. Access to this gate array capability is through Intel's Integrated Design Environment (IDE), a comprehensive set of CAD tools and symbol and simulation model libraries for the development, design, and production of Intel ASIC products. The libraries are supported by popular CAD tools, including Engineering Workstations from Daisy Systems and Mentor Graphics, IBM, and DEC. Intel's initial gate array offerings are its D15A gate array and D15C composite array series, both based on Intel's CHMOS III 1.5 micron dual-layer metal technology. The D15A series features an extensive library of macrocells. The D15C series features the same macrocell library plus special functions implemented efficiently by all-level personalization of the base wafer. The first special function to be included in the D15C series is RAM. Planned additions to the library include Intel 8086 and 82086 peripheral functions.

Product Highlights

- More than 100 unique macrocells in the library, expanding to include LSI and VLSI peripheral functions
- Functionally compatible with the IDE CHMOS III Cell Library for designing cell-based integrated circuits
- 0.7 ns typical gate delay for two-input NAND, fanout of 2; 65 MHz typical D flip-flop toggle rate
- High-density 1.5 micron, dual-layer metal CHMOS III process
- Proven CAD tools allow high block* utilization
- Optional support for Level Sensitive Scan Design (LSSD) featuring automatic test generation
- Flexible options for on-chip RAM
- Selectable performance-level options for SSI and MSI macrocells, expanding total number of available macrocells
- Full line of industry-standard packages
- Controlled Collapsed Chip Connection (C4) bonding option provides increased I/O capability

Table 37. Intel Gate Arrays—1.5 Micron Technology

Gate Arrays				
Device	Equivalent Gates*	Blocks	Max I/O Pins	Min Power Pins
D15A020	2,550	2,000	62	6
D15A040	5,100	4,000	78	6
D15A065	8,287	6,500	112	10
D15A066	8,410	6,600	103	9
D15A070	9,017	7,072	137	9
D15A098	12,495	9,800	112**	10**
D15A100	12,750	10,000	174	9
D15A150	19,125	15,000	174**	9**
Composite Arrays—2304 Bits Configurable RAM				
D15C001	6,196	4,860	103	9
D15C002	10,700	8,392	174	9

*Gate is 2-input NAND equivalent. Experience has demonstrated 1.275 gates/block with six transistors/block. Actual number of gates/block is design dependent.
**Preliminary.

CELL-BASED INTEGRATED CIRCUITS

The 1.5 Micron CHMOS III Cell Library is a comprehensive set of pre-designed, fully characterized functions for the integration of system logic into high-performance, cost-effective semi-custom devices. These cells offer full-customer performance and density. The basic cell library contains logic, memory, I/O, and special function cells. Also available are VLSI cells such as the 80C51BH 8-bit microcontroller and cell equivalents of Intel microprocessor peripheral functions. The library runs on the Daisy Systems and Mentor Graphics engineering workstations. The 1.5 Micron CHMOS III Cell Library is fully second sourced. Intel cell-based ICs are produced using the same advanced, proven process used to produce Intel standard products and are delivered with the same assurance of high quality and reliability.

High Performance

- 0.7 ns propagation delay for two-input NAND with fan-out=2
- 65 MHz DFF toggle rate

Standard Cells

- SSI/MSI cells equivalent to standard TTL functions
- CMOS, TTL, and Schmitt Trigger compatible I/O cells available with a variety of drive levels and ESD protection to 2000V
- Each I/O cell designed with two aspect ratios, optimized for either logic limited or I/O limited designs

Special Function Cells

- Full set of special function cells including compilable RAM, ROM, PLA, and analog functions
- User configurable n-bit counters, registers, magnitude comparators built from "telescoping" cells achieve high performance for repetitive functions

VLSI Cells

- Cell versions of popular Intel standard microprocessors, microcontrollers, and microprocessor peripherals are available in the library. The VLSI cells offer the highest level of microcomputer-based system integration.

  80C51BH ..... 8-bit microcontroller
  82C37A ..... Programmable DMA controller
  82C54 ..... Programmable interval timer
  82C59A ..... Programmable interrupt controller
  82C84 ..... 8086 clock generator
  82C284 ..... 80286 clock generator
  82C88 ..... 8086 bus controller
  82C288 ..... 80286 bus controller

- Intel-supplied test vectors
- All VLSI cells are tested and verified using the equivalent standard product test program, guaranteeing .1% AQL or better.

ASIC Emulators

- ASIC emulator supports code development and "breadboard" simulation of 80C51BH based ASICs.
- Emulator kit includes chip version of UC51 8-bit microcontroller cell, PC-compatible monitoring software, and application note.

Packaging

- Packaging options include through board and surface mount in DIP, PLCC, PQFP, and PGA configurations.

INTEL DESIGN ENVIRONMENT (IDE)

The Intel Design Environment (IDE) provides a flexible system for developing, designing, and producing EPLD, gate array, and cell-based integrated circuits. The system includes complete CAE tool suites as well as symbol libraries and simulation models hosted on a variety of industry-standard CAE platforms. The IDE is supported by an expanding group of Design Centers providing training classes, expert local technical support, and access to Intel mainframes. Designs executed using the IDE are produced using advanced Intel process technology and proven manufacturing capability, with strict adherence to Intel quality and reliability standards.

Design Centers and Regional Applications Specialists

- Local resources for training, library support, design analysis, and consultation
- Access to Intel IDE hardware and software
- Access to Intel's ASIC mainframe design verification system

Libraries Available on Industry Standard CAE Platforms

- Mentor Graphics Environment: all workstations from Mentor Graphics
- Daisy Environment: all workstations from Daisy Systems

Leadership Verification Tools

- Physical layout and design verification tools combine the best of commercially available hardware and software with more than two decades of Intel design expertise.

Proven Manufacturing Capability

- 1.5 micron CHMOS III process for high performance and high density
- Same process used for Intel standard components

Superior Quality and Reliability Levels

- Complete gate array and cell-based qualification program covers process, libraries, and packages—assuring exceptional quality and dependable performance to specifications.
- Special requirements can be accommodated

Semi-Custom Design Methodology

Customers typically complete all design steps through simulation and timing verification, then transfer the design to Intel. At that point, the customer and Intel agree on a Design Specification which will serve as a benchmark throughout manufacturing, assembly, and final test.

SINGLE BOARD COMPUTERS

MULTIBUS® PRODUCTS

The elements that make the "Open System" a reality: It all begins with MULTIBUS System Architecture, the industry standard backplane architecture. The foundation of Intel's microcomputer systems architecture was laid in 1976 with the introduction of the MULTIBUS system bus and Intel's first single board computer product, the iSBC® 80/10 board. It was a solution the microcomputer industry needed to make microprocessor technology easier to use and more readily available for new product design and development. Its widespread use and popularity make it a de facto industry and IEEE standard (IEEE 796).

An important feature of the MULTIBUS Open System architecture has been its ability to adapt to changing technology and a wide variety of increasing system performance needs, while maintaining software and system compatibility. For example, today's MULTIBUS designers can take advantage of Intel's new 32-bit, 80386-based single-board computers for high-performance multiprocessor system applications and Intel's new 16-bit, all CMOS single-board computer for high-reliability, embedded applications.

The bus architecture is the conceptual foundation and physical framework for interfacing the various pieces of the microcomputer system into a family of system solutions. This family now includes a broad array of single board computers, memory expansion boards, of I/O expansion products, packaging products, microsystem software, and integrated microsystems.

The five levels of iSBC expansion supported by Intel's MULTIBUS provide OEMs with the widest range of cost/performance solutions and open system flexibility in the industry.

- The MULTIBUS System Bus—system communication and interconnection
- The iLBX™ Execution Bus—large amounts of high speed memory
- The MULTICHANNEL™ I/O Bus—very high-speed, high-performance I/O
- The iSBX I/O Expansion Bus—low-cost modular I/O
- iSBC MULTIMODULE Add-ons—on-board memory and math expansion
- BITBUS Distributed Control Bus—fast serial connection to microcontroller

Intel continues to develop new iSBC products to meet the industry's need for powerful, cost-effective, single board computer products. There are now more than 90 MULTIBUS expansion boards from Intel. There are also over 250 MULTIBUS vendors providing more than 2500 MULTIBUS compatible products, the largest assortment of compatible products in the industry today.

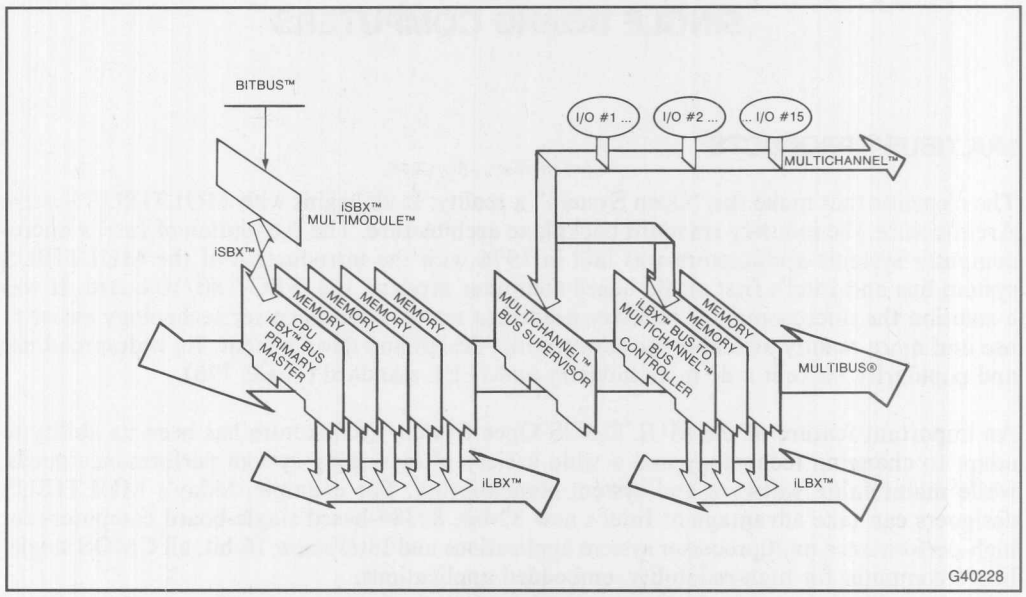


Figure 29. MULTIBUS® Expansion

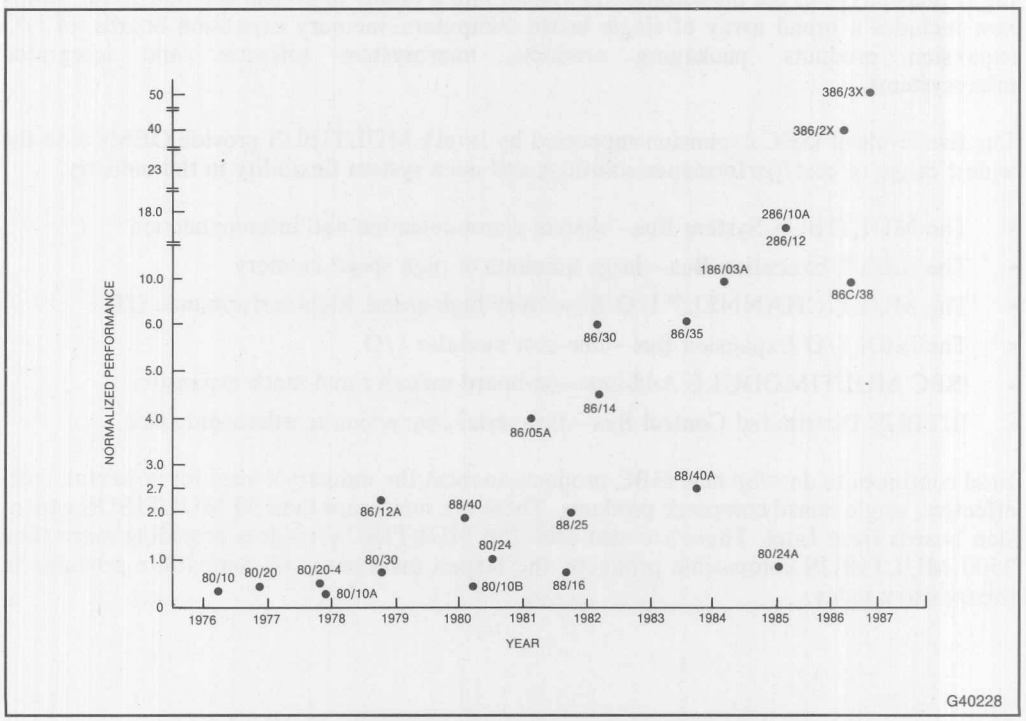


Figure 30. iSBC® CPU Boards—Relative Performance

Table 38. MULTIMODULE™ Expansion Options

MULTIMODULE Boards		iSBC Boards																		
Expansion	Product	80/10B	80/20-4	80/24A	80/30	86/05A	86/12A	86/14	86/30	86/35	86C/38	88/25	88/40A	186/03A	186/51	186/78A	286/10A	286/12	386/2X	386/3X
RAM EPROM	iSBC 341					■					■	■	■	■		■	■	■	■	
RAM EPROM	iSBC 340						■													
H.S. Math	iSBC 337A					■	■	■	■	■	■	■	■							
512K RAM	iSBC 314									■	■									
128K RAM	iSBC 304								■	■	■				■					
8K RAM	iSBC 302					■						■								
4K RAM	iSBC 301												■							
32K RAM	iSBC 300A							■												
32K RAM	iSBC 300						■													
1 MB DRAM	iSBC MM01																		■	■
2 MB DRAM	iSBC MM02																		■	■
4 MB DRAM	iSBC MM04																		■	■
8 MB DRAM	iSBC MM08																		■	■

Table 39. MULTIBUS® CPU Boards

Product	CPU[1]	RAM	EPROM E²PROM	iSBX[2] Expansion Connectors	MULTIMODULE[2] Expansion	Operating[3] System Software
iSBC 386/3X	80386, 80387 20 MHz	1-16 MB	512 KB	1	MMOX	iRMX, iRMK XENIX, UNIX V
iSBC 386/2X	80386, 80387 16 MHz	1-16 MB	512 KB	1	MMOX	iRMX, iRMK XENIX, UNIX V
iSBC 286/12	80286	1 MB	0-256 KB	2	iSBC 341	iRMX-86 iRMX-286 XENIX 286 CP/M 286
iSBC 286/10A	80286	0-128 KB	0-51 KB	2	iSBC 341	
iSBC 186/03A	80186	0-64 KB	0-512 KB	2	iSBC 341	iRMX-86
iSBC 86C/38	80C86	1 MB	32-512 KB	2	iSBC 304 iSBC 314 iSBC 337/A	iRMX
iSBC 86/35	8086-2	512 KB	32-256 KB	2	iSBC 304 iSBC 314 iSBC 337/A	iRMX-86
iSBC 86/30	8086-2	128 KB	8-64 KB	2	iSBC 304 iSBC 337/A	iRMX-86 CP/M 86
iSBC 86/14	8086-2	32 KB	8-64 KB	2	iSBC 300A iSBC 337/A	iRMX-86 CP/M 86
iSBC 86/12A	8086	32 KB	4-16 KB	0	iSBC 300 iSBC 340 iSBC 337/A	iRMX-86 CP/M 86
iSBC 86/05A	8086-2	8 KB	8-16 KB 8-256 KB	2	iSBC 302 iSBC 341 iSBC 337/A	iRMX-86 CP/M 86
iSBC 88/40A	8088 (8/16-bit)	4 KB	16-32 KB	3	iSBC 301 iSBC 341 iSBC 337/A	iRMX-86
iSBC 88/25	8088 (8/16-bit)	4 KB	4-64 KB	2	iSBC 302 iSBC 341 iSBC 337/A	iRMX-86 CP/M86
iSBC 80/30	8085A (8-bit)	16 KB	8-8 KB	0	iSBC 304	CP/M 80
iSBC 80/24A	8085A (8-bit)	8 KB	4-32 KB	2	iSBC 301	CP/M 80
iSBC 80/20-4	8080A (8-bit)	4 KB	4-8 KB	0	—	CP/M 80
iSBC 86/10B	8080A	1K-4K	4-16 KB	1	—	—

NOTES:
1. See Microprocessor Section.
2. See following tables.
3. See Software Section.

Table 40. MULTIBUS® Memory Expansion Boards

Product	Memory Type	Memory Size (Bytes)	Parity	iLBX Interface	High-Speed Interface
iSBC 28A	Dynamic RAM	128K	Yes	No	No
iSBC 056A	Dynamic RAM	256K	Yes	No	No
iSBC 012B	Dynamic RAM	512K	Yes	No	No
iSBC 012C	Dynamic RAM	512K	Yes	No	No
iSBC 010CX	Dynamic RAM	1M	Yes	Yes	No
iSBC 020CX	Dynamic RAM	2M	Yes	Yes	No
iSBC 012CX	Dynamic RAM	512K	Yes	Yes	No
iSBC 012EX	Dynamic RAM	512K	Yes	Yes	Yes
iSBC 010EX	Dynamic RAM	1M	Yes	Yes	Yes
iSBC 020EX	Dynamic RAM	2M	Yes	yes	Yes
iSBC 040EX	Dynamic RAM	4M	Yes	Yes	Yes
iSBC 428	28-Pin Universal Site	0-1M	No	Yes	No
iSBC 300	Dynamic RAM	32K	No	No	No
iSBC 300A	Dynamic RAM	32K	No	No	No
iSBC 301	Static RAM	4K	No	No	No
iSBC 302	Static RAM	8K	No	No	No
iSBC 304	Dynamic RAM	128K	No	No	No
iSBC 340	24-Pin EPROM	4 Jedec Sites	No	No	No
iSBC 341	24/28-Pin EPROM/RAM	4 Jedec Sites	No	No	No
iSBC MM01	DRAM	1 MB	Yes	No	Yes
iSBC MM02	DRAM	2 MB	Yes	No	Yes
iSBC MM04	DRAM	4 MB	Yes	No	Yes
iSBC MM08	DRAM	8 MB	Yes	No	Yes

Table 41. MULTIBUS® Memory and I/O Expansion Boards

Product	RAM	EPROM	Serial I/O	Parallel I/O	
				Lines	Connectors
iSBC 108A	8K	4-32K	1 (RS232C)	48	2
iSBC 116A	16K	4-32K	1 (RS232C)	48	2

Table 42. MULTIBUS® Data Communications and Networking

Product	CPU	RAM	EPROM E²PROM	iSBX™ Expansion Connectors	Data Comm Features
iSBC 534	—	—	—	—	4 serial channels, 16-bit parallel
iSBC 544	8085A	16K	4-8K	—	4 serial channels, 10 parallel line
iSBC 552A	80186 82586	12, 28-pin Jedec Sites	12, 28-pin Jedec Sites	—	Ethernet communication, full IEEE 802.3 spec
iSBC 554	80186	256K	4, 28-pin Jedec Sites	1	MAP communications layers 1-7, 10 Mbps IEEE 802.4, broadband token bus interface
iSBC 88/45	8088-2 (8/16-bit)	16K	64-128K	2	3 communication channels, HDLC/ SDLC/asynch/ sync
iSBC 188/56	80188 (8 MHz)	256K	2, 28-pin Jedec Sites	2	8 serial channels, HDLC/SDLC/ asynch/synch
iSBC 186/51	80186 82586	128-256K	6, 28-pin Jedec Sites	2	Ethernet, full IEEE 802.3 spec, two serial channels
iSBX 350	—	—	—	—	24 parallel I/O, single-wide
iSBC 351	—	—	—	—	1 serial channel, single-wide
iSBC 352	—	—	—	—	1 serial channel single-wide, SDLC/HDLC only
iSBC 354	—	—	—	—	2 serial channels, single-wide

Table 43. MULTIBUS® Analog I/O Expansion Boards

Product	Input Channels	Output Channels	MULTIMODULE Type
iSBX 311	8-16		iSBX Single-wide
iSBX 328		8	iSBX Single-wide

Table 44. MULTIBUS® Digital Interface and I/O Expansion Boards

Product	Description	I/O Capacity	Type
iSBC 569	Intelligent 8085-driven Digital I/O Slave	48 I/O Lines	MULTIBUS
iSBC 519	General Purpose Digital I/O	72 I/O Lines	MULTIBUS
iSBC 556	Optically-Isolated Digital I/O	48 I/O Lines	MULTIBUS
iSBX™ 488	IEEE 488 GPIB/HPIB	16 I/O Lines 16 Control	Single-wide iSBX MULTIMODULE
iSBC 589	Intelligent MULTICHANNEL DMA Controller	8/16-bit 1 MULTICHANNEL Port 2 iSBX Connectors	MULTIBUS
iSBC 580	MULTICHANNEL Bus to iLBX Bus Interface	1 16-bit MULTICHANNEL 1 16-bit iLBX Interface	MULTIBUS
iSBX 344A	BITBUS System Interface Module	1 BITBUS Interface	Double-wide iSBC MULTIMODULE

Table 45. MULTIBUS® High Speed Math Boards

	Chip	Speed	Fixed	Floating	Transcendental	
iSBX 331	8231	4 MHz	Yes	Yes	Yes	
iSBC 337	Execution Time (Microseconds)		Multiply	Divide	Add	Subtract
		Fixed Floating Point	28 29	48 40	20 29	20 37
iSBC 337A	Execution Time (Microseconds)	Fixed Floating Point	12 13	20 16	8 12	8 15

Table 46. Mass Storage Controllers

Product	No. of Boards	Interface Supported Transfer Rates	No. of Drives Supported	S/W Support
iSBC 208	1	SA800/850; SA400/450/460 8″ −62.5K bytes/sec 5¼″ −31.25K bytes/sec	4	iRMX-86
iSBC 215G	1	ANSI X3T9/1226 (1M byte/sec transfer rate) in burst mode	4	iRMX-86 XENIX
iSBC 215G Kit (includes external data separator)	2	ST506/412 (transfer rate 5M bits/sec)	4	iRMX-86 XENIX
iSBC 217C	Single-wide MULTIMODULE	QIC-02 or 3M HCD-75 (90K, 30K, 17K—depending on tape drive speed)	4	iRMX-86 XENIX
iSBX 218A	Double-wide MULTIMODULE	SA800/850, SA400/450/460 5¼″ −31.25K bytes/sec 8″ −62.5K bytes/sec	4	iRMX-86 XENIX iRMX-286
iSBC 220	1	SMD (transfer rate 10M bits/sec)	4	iRMX-86
iSBC 226	1	Enhanced SMD (transfer rate 15M bits/sec)	2	iRMX-86
iSBC 186/03A	1	SCSI-single host environment (transfer rate 1.2M bytes/sec asynchronous)	Single target environment	iRMX-86
iSBC 214	1	ST506/412 (5M bits/sec)	2	iRMX-86
		SA 450/460 (31.25K bytes/sec)	4	iRMX-286
		QIC-02 (90K, 30K, 17K—depending on tape drive and speed)	4	XENIX

Table 47. MULTIBUS® Human Interface

Product	Display Resolution	Character Size	Color or B&W	Frame Rate
iSBX 270	80 Characters 24/80 24 Lines	5 × 7, 7 × 9 6 × 8	8-color or B&W	50 Hz or 60 Hz
iSBX 275	512 × 512 × 1 256 × 256 × 3	Up to 8 × 8	8-color or B&W	50 Hz or 60 Hz
iSBC 186/78A	640 × 480 × 4 1024 × 768 × 1	N/A	16 color or 16 gray	50 Hz or 60 Hz

DISTRIBUTED CONTROL MODULES

Intel Distributed Control Module (iDCM) products provide building blocks for construction of real-time distributed control systems based on the BITBUS interconnect. This serial bus architecture addresses many of the limitations inherent in traditional connection methods. For instance, future system cost reductions are limited in systems based on parallel bus structures due to their electrical and mechanical characteristics. Other traditional connection methods such as current loops and RS232C do not provide sufficient performance or flexibility for complex industrial control applications. In addition, although there are numerous industry standards for connection microprocessors, the MULTIBUS and the STD-bus for example, there is no standard connection for microcontrollers. The BITBUS interconnect combines existing standards with new standard interfaces to provide the optimal solution for difficult distributed control problems.

The iDCM products combine hardware and software for use in applications that would benefit most from employing distributed architectures. Applications such as robotics, process control, data acquisition and control, and environmental control are a few examples.

Table 48. Standard BITBUS™ Interfaces

Interface	Specification
Electrical	RS485
Cable	Ten-conductor flat ribbon or one- to two-wire twisted pair
Back-plane connector	Sixty-four-pin Standard DIN
End-cable connector	3M #3446-1302 female
Control-board form-factor	Single-height, double-depth Eurocard
Data link control	Synchronous data-link control-based protocol
Data transfer rate	62.5K baud, 375K baud, and 2.4M baud
Message formats	Compatible with iDCX format command/response/status
Common command sequences	Integral Remote Access and Control (RAC) function
Operating systems	S/W interface libraries for iRMX-86, 286, PC/MS-DOS, XENIX, and ISIS (for iPDS™ only)

Benefits of Distributed Architectures

Distributed architectures are intrinsically more reliable than centralized architectures. In a centralized control system, a central controller failure results in a system-wide failure. Distributed systems can be configured to prevent this. Also, distributed systems are more cost effective and more easily modified. For instance, performance improvements in centralized systems are expensive and do not concentrate improvements in the areas where they are needed most. In distributed systems, only the specific parts of the system that require enhancement need be modified. Most importantly, control systems based on distributed architectures have less difficulty responding to the external environment because they have less to manage.

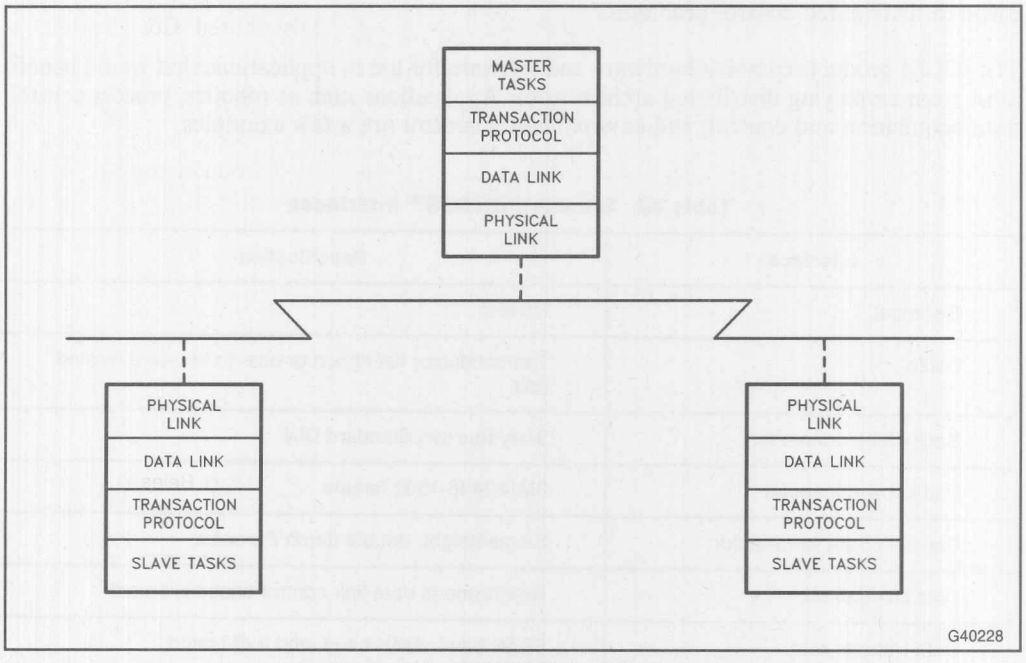


Figure 31. BITBUS™ Architecture

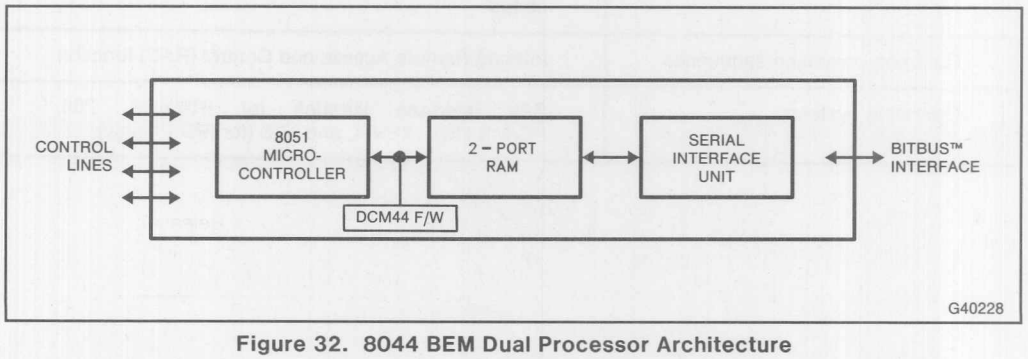


Figure 32. 8044 BEM Dual Processor Architecture

The BITBUS™ Interconnect

The BITBUS interconnect is a serial bus optimized for high-speed transfer of short-control messages in a hierarchical system. In order to provide an easy-to-use high-performance serial interconnect, transparent to the applications programmer, high-level interfaces are specified. These interfaces include: the message structure and protocol for a multitasking environment and a set of high-level commands for remote I/O access and application task control. As with traditional bus specifications, the electrical and data protocol levels have been defined.

The BITBUS microcontroller interconnect bus was introduced in early 1984. It is designed to facilitate distributed intelligent control of industrial machines and I/O such as robots, numerical control machines, and process controllers. The BITBUS interconnect makes possible simple, high-performance communications among Distributed Control Modules (DCM) and their associated MULTIBUS and PC Bus systems.

The BITBUS interconnect is based on Intel's 8044, which incorporates on a single chip the industry standard 8051 microcontroller and a high-speed, SDLC-based controller to provide fast and reliable transfer of control commands and responses. Distribution of control functions over the flexible, serial BITBUS interconnect standard will make the coordinated, automated factory more practical and cost effective.

Table 49. BITBUS™ Products

Product	Description
iSBX 344A BITBUS Intelligent Controller MULTIMODULE™ Board	• BITBUS MULTIMODULE expansion board for MULTIBUS Single Board Computers. • High-performance 12 MHz 8044 controller. • Integral firmware including the DCX 51 Release 2.0 Real-Time Multitasking Executive. • Memory sites for user's application programs.
iPCX-344A BITBUS IBM PC Interface Board	• IBM PC AT/XT Network Form factor board interface to BITBUS iRCB boards. • External memory sites. • Internal Firmware optimized for Real-Time control applications on BITBUS. • Fully compatible with Intel's MS/PC-DOS Based Development Tools. • High performance 8044 Single Chip Microcontroller. • Power-up diagnostics with LED's.
iRCB 44/10A BITBUS Digital I/O Remote Controller Board	• BITBUS standalone remote controller board with twenty-four programmable digital I/O lines. • iSBX connector for low-cost expansion. • Eurocard form-factor. • High-performance 12 MHz 8044 controller. • Integral firmware including the iDCX Release 2.0 51 Real-Time Multitasking Executive. • Memory sites for user's application programs.

Table 49. BITBUS™ Products (Cont'd.)

Product	Description
iRCB 44/20A BITBUS Analog I/O Controller Board	• Standalone remote controller using 12 MHz 8044 microcontroller. • Sixteen single-ended analog input channels, ±10V, ±5V, 0-5V, and 0-10V. • Two analog output channels, ±10V, ±5V, 0-10V, and 4-20 mA. • Programmable gain and 4-20 mA support. • iSBX connector for low-cost expansion. • Eurocard form-factor. • Integral firmware, including iDCX Release 2.0 51. • Two twenty-eight-pin memory sites, one with SRAM standard.
iRCX 910/920 Termination and Isolation Boards	• iRCX-910 provides termination and electrical isolation for 24 points of digital I/O. • iRCX-920 provides termination and electrical isolation for 18 points of analog I/O. • Panel mountable or 19″ rack mountable with customer-supplied mounting frame. • Use industry standard signal conditioning modules.
DCS100 BITBUS Toolbox Host Software Utilities	• Interactive software monitor for development and run-time. • High-performance interfaces for iRMX-86/286, iPDS, ISIS, and MS-DOS operating systems.
DCS110 Bitware	• DCM44 code supports debug of BITBUS applications using Intel In-Circuit Emulators. • Includes DCX51 interface library to support calls to the (8044 BEM) on-chip executive.
DCS120 Programmer's Support Package	• Includes DCX51 Interface library to support calls to the (8044 BEM) on-chip executive.
iDCX51 Release 2.0 Executive	• Real-time Multitasking Executive for the MCS-51 Microcontroller Family. • Provides run-time scheduling services, message passing — supports up to eight tasks. • Only 2.2K bytes of code.

MULTIBUS® II ARCHITECTURE

MULTIBUS II was developed by Intel Corporation in 1984 and was approved as the IEEE Standard 1296 in June 1987. Requirements ranging from handling high-performance 32-bit microprocessor CPU boards through increasing system performance and bandwidth through multiprocessing are addressed by the MULTIBUS II bus architecture specification. Coupled with this demand for increasingly higher performance are other factors determined to be equally critical in developing advanced technology systems. These other factors include more and faster memory and I/O capabilities, highly reliable systems with high data integrity, flexible software with real-time applications, systems that are easy to use, and improved methods for sharing system information, resources, and processing.

MULTIBUS II bus is an open architecture suitable for a wide range of processor-independent applications. The three new MULTIBUS II bus structures are the Parallel System Bus (iPSB), a 32-bit bus with 40M byte/sec throughput; the Local Bus Extension (iLBX II), offering high-speed (48M byte/sec) access to large amount of off-board memory; and the Serial System Bus (iSSB), a low-cost serial interconnect offering the flexibility of MULTIBUS II boards being physically extended up to 10 meters apart. Carried over from the MULTIBUS I architecture is the iSBX I/O Expansion Bus. Choices can be made between implementation of any or all of the buses, depending on what functionality is to be optimized, a philosophy known as "functional partitioning."

An additional strength of MULTIBUS II rests with the definition of a standard bus interface. Intel has implemented this bus interface definition using VLSI technology and thus provides the key to multiprocessing with intelligent boards that are processor-independent. The Message Passing Coprocessor (MPC) is a semi-custom VLSI device that minimizes the real estate required for full bus interface, maximizes bus performance, increases reliability, lowers costs, and increases design flexibility. The MPC offloads the local on-board CPU by handling all bus arbitration and the message space interface, eliminating the interface bottleneck present in traditional shared memory.

MULTIBUS® II PRODUCTS

Intel's family of MULTIBUS II products allow users to take immediate advantage of the bus advances outlined in the MULTIBUS II Architecture Specification. Using the building blocks offered by Intel in the open MULTIBUS II, bus architecture provides the flexibility and ease of use demanded by either today's high performance applications or tomorrow's technology-driven markets.

Table 50. MULTIBUS® II Single Board Computer CPU Products

Product	Description
iSBC 386/116, 120 Single Board Computer	• 16 or 20 MHz 32-bit 80386 microprocesor (116 or 120) • MULTIBUS II iPSB interface for multimaster configurations and multiprocessing system expansion • High-speed 64K byte static RAM cache on-board providing zero-wait-state memory reads • 80387 Numeric Data Co-Processor • Four DMA channels supplied by the 82258 Advanced DMA controller with 8M bytes/sec transfer rate • MULTIBUS II interconnect space for software configurability and diagnostics • Resident firmware to support Built-In-Self-Test (BIST) at power-up and power-fail recovery • 1, 2, 4 or 8M bytes of on-board dual-ported dyanmic RAM memory with parity error detection; expandable to 16M bytes • 8- or 16-bit iSBX™ bus (IEEE P959) interface with DMA for I/O expansion • One RS232C serial I/O port • Double-high Eurocard standard form factor, pin and socket DIN connectors

Table 50. MULTIBUS® II Single Board Computer CPU Products (Cont'd.)

Product	Description
iSBC 286/100A Single Board Computer	• 8 MHz 80286 microprocessor • MULTIBUS II iPSB interface for multimaster configurations and multiprocessing system expansion • MULTIBUS II iLBX II (Local Bus Extension) interface for high-speed memory expansion • MULTIBUS II interconnect space for software configurability and diagnostics • Resident firmware to support Built-In Self-Test (BIST) power-up diagnostics • Optional 80287 Numeric Data Co-Processor (socket on-board) • Two iSBX bus interface connectors for I/O expansion bus • Four DMA channels supplied by the 82258 Advanced DMA Controller with 8M bytes/sec transfer rate • 16 levels of vectored interrupt control and up to 255 distinct interrupt sources and 255 interrupt destinations are supported using message-based interrupts • Two 28-pin JEDEC sites • Twenty-four programmable I/O lines configurable as SCSI interface, Centronics interface, or general purpose I/O • Two programmable serial interfaces, one RS232C, the other RS232C or RS422A compatible • Double-high Eurocard standard form factor, pin and socket DIN connectors
iSBC 186/100 Single Board Computer	• 8 MHz 80186 embedded Controller • MULTIBUS II iPSB interface for multimaster configurations and multiprocessing system expansion • Two programmable serial interfaces, one RS232C DTE and the other RS422 DTE • One parallel port configurable for SCSI, Centronics, or general purpose • Socket for full iSBX compatibility and BITBUS support • 512K byte Dual Port DRAM supported on iPSB • 8 MHz Advanced Direct Memory Access Controller (ADMA) plug-in option • MULTIBUS II interconnect space fully supported with 8751 controller • Double high Eurocard standard form factor, pin and socket DIN connectors

Table 51. MULTIBUS® II Memory Products

Product	Description
iSBC MEM/312 Cache-Based MULTIBUS II RAM Board	• 512K byte dual port RAM board • High-speed cache-based boards with 8K bytes of cache RAM • 32-bit MULTIBUS II Parallel System Bus (iPSB) and Local Bus Extension (iLBX II) interface support • Zero wait state over iLBX II on a cache hit, one wait state for cache misses, and writes at 8 MHz • Double-high Eurocard standard form factor, pin and socket DIN connectors • MULTIBUS II software interconnect support for dynamic memory configuration and diagnostics with no jumpers necessary on the board • Built-In-Self-Test (BIST) diagnostics on-board with both LED indicators and software access to error information • Automatic memory initialization at power-up and at power-fail recovery • Byte-parity error detection
iSBC MEM/310 Cache-Based MULTIBUS II RAM Board	• 1M byte dual port RAM board • High-speed cache-based boards with 8K bytes of cache RAM • 32-bit MULTIBUS II Parallel System Bus (iPSB) and Local Bus Extension (iLBX II) interface support • Zero wait state over iLBX II on a cache hit, one wait state for cache misses, and writes at 8 MHz • Double-high Eurocard standard form factor, pin and socket DIN connectors • MULTIBUS II software interconnect support for dynamic memory configuration and diagnostics with no jumpers necessary on the board • Built-In-Self-Test (BIST) diagnostics on-board with both LED indicators and software access to error information • Automatic memory initialization at power-up and at power-fail recovery • Byte-parity error detection
iSBC MEM/320 Cache-Based MULTIBUS II RAM Board	• 2M byte dual port RAM board • High-speed cache-based boards with 8K bytes of cache RAM • 32-bit MULTIBUS II Parallel System Bus (iPSB) and Local Bus Extension (iLBX II) interface support • Zero wait state over iLBX II on a cache hit, one wait state for cache misses, and writes at 8 MHz • Double-high Eurocard standard form factor, pin and socket DIN connectors • MULTIBUS II software interconnect support for dynamic memory configuration and diagnostics with no jumpers necessary on the board • Built-In-Self-Test (BIST) diagnostics on-board with both LED indicators and software access to error information • Automatic memory initialization at power-up and at power-fail recovery • Byte-parity error detection

Table 51. MULTIBUS® II Memory Products (Cont'd.)

Product	Description
iSBC MEM/340 Cache-Based MULTIBUS II RAM Board	• 4M byte dual port RAM board • High-speed cache-based boards with 8K bytes of cache RAM • 32-bit MULTIBUS II Parallel System Bus (iPSB) and Local Bus Extension (iLBX II) interface support • Zero wait state over iLBX II on a cache hit, one wait state for cache misses, and writes at 8 MHz • Double-high Eurocard standard form factor, pin and socket DIN connectors • MULTIBUS II software interconnect support for dynamic memory configuration and diagnostics with no jumpers necessary on the board • Built-In-Self-Test (BIST) diagnostics on-board with both LED indicators and software access to error information • Automatic memory initialization at power-up and at power-fail recovery • Byte-parity error detection
iSBC MEM/601 Universal Site MULTIBUS II Memory Board	• Two banks of eight 28-pin JEDEC sockets • ROM and EPROM up to 64K × 8 • E^2PROM, SRAM, and iRAM up to 32K × 8 • 512 × 8 NVRAM • Full iLBX II and iPSB support • Data retention after power-fail with optional lithium battery back-up on-board

Table 52. MULTIBUS® II Microcommunications Products

Product	Description
iSBC 186/410 Serial Communications Computer	• 8 MHz 80186 Embedded Controller • Six serial communication channels, expandable to 10 channels via iSBX bus connectors • Four DMA channels supplied by the 82258 Advanced DMA controller with 8M bytes/sec transfer rate • Supports RS232C only on four channels; RS422A or RS232C interface configurable on two channels • 256K bytes DRAM provided, expandable to 512K bytes DRAM on board • MULTIBUS II interconnect space for software configurability and diagnostics • Resident firmware to support Built-In-Self-Test (BIST) at power-up and power-fail recovery • Four 28-pin JEDEC memory sites • Two iSBX connectors for I/O expansion • Double-high Eurocard standard form factor, pin and socket DIN connectors

Table 52. MULTIBUS® II Microcommunications Products (Cont'd.)

Product	Description
iSBC 186/530 Ethernet (IEEE 802.3) Communications Engine	• 8 MHz 80186 Embedded Controller • 82586 Local Area Network Coprocessor for Ethernet (IEEE 802.3) compatible networking capability • 256K bytes DRAM provided, expandable to 512K bytes DRAM on board • MULTIBUS II Interconnect space for software configurability and diagnostics • Resident firmware to support Built-In-Self-Test (BIST) at power-up and power-fail recovery • MULTIBUS II iPSB Interface for multimaster configurations and multiprocessing system expansion • Four 28-pin JEDEC memory sites • One serial debug port

Table 53. MULTIBUS® II Support Products

Product	Description
iSBC CSM/001 Central Services Module	• Integrates MULTIBUS II central system functions on a single board • MULTIBUS II Parallel System Bus (iPSB) clock generation for all agents interfaced to the MULTIBUS II iPSB bus • System-wide reset signals for power-up, warm start, and power failure/recovery • System-wide time-out detection and error generation • Slot I.D. and Arbitration I.D. initialization • MULTIBUS II interconnect space for software configurability and diagnostics • Built-In-Self-Test (BIST) power-up diagnostics with LED indicator and error reporting accessible to software via interconnect space • General purpose link interface to other standard (MULTIBUS I) or proprietary buses • Time-of-day clock support with battery back-up on board • Double-high Eurocard standard form factor, pin and socket DIN connectors
82389 Message Passing Coprocessor (MPC), A MULTIBUS II bus interface controller	• High-integration VLSI device • Single-chip interface for interprocessor communication on the iPSB bus (message passing) • Host-independent CPU interface 8, 16, or 32-bit • Interconnect interface for 8-bit microcontroller • Dual-port memory support • Bus arbitration, interrupt and error handling • CMOS technology • 149-lead-pin grid array

Table 53. MULTIBUS® II Support Products (Cont'd.)

Product	Description
iSBC LNK/001 MULTIBUS II to MULTIBUS I Link Board	• Dual port 128K byte DRAM programmable via MULTIBUS II interconnect space • Supports 16- and 24-bit address and 8- and 16-bit data paths • 16M bytes of MULTIBUS I memory maps into MULTIBUS II memory space • 32K bytes of MULTIBUS I/O memory maps into MULTIBUS II I/O memory space • Converts MULTIBUS I interrupts into MULTIBUS II interrupt messages • MULTIBUS I form factor board connecting to iSBC CSM/001 via flat ribbon cable

Table 54. MULTIBUS® II Test Products

Product	Description
MULTIBUS II GPTF General Purpose Tester—Functional	• Functional tester for testing MULTIBUS II boards in a systems environment • Tests up to four MULTIBUS II boards simultaneously in a range from ambient temperature to 70°C • Voltage and temperature margins are software controlled • Multiprocessor, multitesting functional tester with totally automated test sequence requires minimum human interface • Powerful command language for troubleshooting and evaluation • One free STBL (System Test Board Level) test is included (additional test programs are available for Intel MULTIBUS II boards) • Video monitor for error message display and test status • Bus drawer feature on P2 connector allows user flexibility to test boards with different types of P2 interfaces • Safety features including thermal cut out at 90°C • Available in either USA, Japan, or International power configuration

Table 55. MULTIBUS® II Packaging Products

Product	Description
iSBC PKB/606 and iSBC PKG/609 MULTIBUS II Card-cage Assemblies	• Available in two sizes to hold up to six or nine MULTIBUS II boards • Designed to mount inside a chassis or other enclosure • Uses a six-layer Parallel System Bus (iPSB) backplane • All lines fully terminated per the iPSB MULTIBUS II specification • Assembly uses aluminum extrusion construction for strength and rigidity • Accommodates Intel iSBC PKG/902 and iSBC PKG/903 two- and three-slot iLBX II backplanes
iSBC PKG/902 and iSBC PKG/903 MULTIBUS II iLBX II Backplanes	• Provides iLBX II interconnect for fastest CPU and off-board data memory transfers • Designed to mount in MULTIBUS II card assemblies • Available in two-slot (iSBC PKG/902) and three-slot (iSBC PKG/903) sizes • Uses a fully terminated six-layer backplane • Includes a 10-pin connector for BITBUS™ applications • Meets all electrical and mechanical requirements of the MULTIBUS II specification
iSBC PGK/622 MULTIBUS II Front Panels	• Front panels for attaching to custom MULTIBUS II boards, mounting iSBX MULTIMODULES, or filling empty slots in MULTIBUS II systems • Full adherence to MULTIBUS II specification with "U" shaped extruded aluminum to meet EMI/RFI requirements • Kit contains front panels, ejector tabs, and all mounting hardware

Table 56. MULTIBUS® II Development Platforms

Product	Description
MDP01R	• Ready to run MULTIBUS II system based on one 80386-based SBC with full message passing, with 4 MB RAM • Includes iRMX II operating system • 80 MB with tape, and floppy • Terminal controller with six ports
MDP02R	• Same as MDP01R with two 80386 CPU boards • Good system for developing multiprocessor applications
MDP01	• Same as MDP01R except it includes the UNIX SYS V.3 operating system instead of the iRMX II operating system
MDP02	• Same as MDP01 with two 80386 CPU boards

Table 57. MULTIBUS® II Peripheral Controller Products

Product	Description
iSBC 186/224 MULTIBUS II Peripheral Controller Board	• High-performance peripheral controller with 80186 embedded controller, 128K byte DRAM, track caching, and DMA • Winchester interface supports up to 4 ST506/412, 5¼″ drives, on board diagnostics, and ECC • Tape interface supports up to 4 QIC-02 streaming tape drives • Floppy interface supports up to 4 5¼″ floppy drives, single or double sided, single or double density • Peripheral Communication Interface (PCI) gives command queing capability • Real-time multitasking operating system

Table 58. MULTIBUS® II Compatible iSBX™ MULTIMODULES™

Product	Description
iSBX 331	• High speed math board for fixed and floating point math
iSBX 258	• Interface MULTIMODULE board for Intel bubble cassette system
iSBX 350	• Parallel digital I/O MULTIMODULE board
iSBX 351	• Serial communication MULTIMODULE board
iSBX 354	• Dual channel serial digital I/O MULTIMODULE board
iSBX 488	• General Purpose Interface Bus (GPIB) MULTIMODULE board
iSBX 311	• Analog input MULTIMODULE board
iSBX 328	• Analog output MULTIMODULE board
iSBX 344A	• BITBUS distributed control bus MULTIMODULE board

NOTE:
All MULTIMODULE boards are fully functional with the MULTIBUS II product line. This listing indicates which MULTIMODULE boards will attach directly to the CPU board without requiring any additional cabling.

PERSONAL COMPUTER ENHANCEMENT PRODUCTS

Intel's Personal Computer Enhancement Operation (PCEO) offers a variety of add-in products for IBM PCs and compatibles through retail distribution channels. The product line includes an Intel 80386-based performance enhancement board, memory and multi-function boards, and math coprocessors.

Inboard™ 386 FAMILY

Inboard 386 is a performance enhancement board for IBM PC/AT and compatibles.

Inboard™ 386

The Inboard 386 brings the power of Intel's 16 MHz 80386 to 80286 systems. It supports conventional, expanded, and OS/2 (extended) memory and features zero wait state cache memory. The 32-bit memory is expandable to 1M byte. This add-in board doubles the performance of IBM PC/ATs.

Inboard™ 386 Installation Kit for IBM PC AT

This kit connects Inboard 386 to the IBM PC AT or IBM 3270 PC AT. It includes cable, manual, software, chip pullers, crystal, jumper storage containers for 80286 and 80287, and plug for the empty 80287 socket.

Inboard™ 386 Installation Kit for IBM PC AT-Compatibles

This kit connects Inboard 386 to COMPAQ DESKPRO 286, Tandy 3000, and other compatibles with a removable 80286. Includes cable, manual, software, chip pullers, jumper, socket covers, storage containers for the 80286 and 80287, and plug for the empty 80287 socket.

Inboard™ 386 Piggyback Memory

Up to 2M bytes of memory can be added to the Inboard 386 with Piggyback Memory Board to the Inboard 386.

Above™ BOARD FAMILY

Above Boards topple the 640K conventional memory barrier imposed by DOS 3.X, increasing the personal computer's memory capacity to 8M bytes above the previous 640K limit. Four models are available; all are supported by a variety of major software packages.

All Above Boards feature RAM disks, a print buffer, and diagnostic software. In addition, all boards are covered by a five-year warranty.

The Above Board/PC and the Above Board PS/PC feature menu-driven installation and provide conventional and expanded memory. The Above Board 286 and the Above Board PS/286 feature switchless and jumperless installation provide conventional, expanded, and OS/2 (extended) memory.

Above™ Board/PC

The Above Board/PC fills out conventional memory and adds up to 2M bytes of expanded memory in an IBM PC, XT, or compatible.

Above™ Board PS/PC

The Above Board PS/PC is the new standard in multifunction cards for PCs, XTs, and compatibles. It has a parallel and a serial port, clock/calendar with battery backup, and up to 1.5M bytes of memory.

Above™ Board 286

The Above Board 286 is a memory expansion board for the IBM PC AT, PC XT 286, and compatibles running at 12.5 MHz and IBM PC, XT, Personal System/2 Model 30, and compatibles running up to 8 MHz. Provides conventional, expanded, and in 286-based systems, OS/2 (extended) memory. Expandable to 2M bytes.

Above™ Board PS/286

The Above Board PS/286 is a multifunction board for the IBM PC AT, PC XT 286, and compatibles running up to 12.5 MHz and IBM PC, XT, Personal System/2 Model 30, and compatibles running at 8 MHz. Includes a parallel and serial port; an optional second serial port is available. Provides conventional, expanded, and in 286-based systems, OS/2 (extended) memory. Expandable to 2M bytes.

Above™ Board Piggyback Memory

Up to 2M bytes of memory can be added to the Above Board 286 or Above Board PS/286 with a Piggyback Memory Board.

Table 59. 80386 Processor Board

Model Number	Product	Maximum Total Memory
For IBM PC AT and compatibles:		
PCIB3000	Inboard™ 386 with 0K* With Piggyback Memory Board	1 MB 3 MB

NOTES:
*These boards can be configured with up to 384K of conventional memory, with the remainder available as OS/2 (extended) memory or as Lotus/Intel/Microsoft expanded memory.

Table 60. Memory and Multifunction Boards

Model Number	Product	Maximum Total Memory
For IBM PC, XT, and compatibles:		
PCMB1010	Above Board/PC with 64K*	512 KB
PCMB1020	Above Board/PC with 256K*	2 MB
PCMB1110	Above Board PS/PC with 64K*	384 KB
PCMB1120	Above Board PS/PC with 256K*	1.5 MB
For the IBM PC AT, PC XT 286, and compatibles running at 12.5 MHz and IBM PC, XT, Personal System/2 Model 30, and compatibles:		
PCMB4020	Above Board 286 with 512K** With Piggyback Memory Board	2 MB 4 MB
PCMB4120	Above Board PS/286 with 512K** With Piggyback Memory Board	2 MB 4 MB

NOTES:
*These boards can be configured with up to 384K of conventional memory, with the remainder available as expanded memory.

**These boards can be configured with up to 128K of conventional memory, with the remainder available as expanded and/or OS/2 (extended) memory.

8087/80287/80387 MATH COPROCESSOR FAMILY

Intel's Math Coprocessors can dramatically boost your PC's performance by speeding math-intensive calculations (including spreadsheets and graphics). Math Coprocessors work with hundreds of major personal computer software packages, and they are quick and easy to install. The following table matches Math Coprocessors to computers.

Table 61. Math Coprocessor

Coprocessor	System and Speed of System
8087	For 5 MHz IBM PC, XT, and compatibles.
8087-2	For 8 MHz IBM PC and compatibles.
80287	For 6 and 8 MHz IBM PC ATs, compatibles, and accelerator boards.
80287-8	For IBM PC AT compatibles and accelerator boards operating faster than 8 MHz.
80287-10	For IBM Personal System/2 Models 50 and 60 and other 80286-based systems or accelerator boards running at 10 MHz or faster.
80387-16	For Inboard 386 and 80386-based systems or accelerator boards that contain an 80387 socket.

PCEO SALES AND SUPPORT

PCEO products are sold through retail channels both nationally and internationally to distributors and computer dealers, never direct to the customer.

We offer an industry-leading five-year product warranty and offer a toll free information/technical support line, (800) 538-3373.

OEM SYSTEMS

Today, our customers are seeking Intel technology at levels beyond that of the microprocessor. Market opportunities have mandated a quicker time to market than our customers could achieve by designing a system themselves. They also need integrated systems that are flexible in design, allowing for both future product enhancements and an easy upgrade path to future VLSI, and are designed to industry standards.

Intel developed the Series 300 family of integrated systems based on the MULTIBUS architecture to fill this need. The family offers a range of highly integrated microcomputer systems, communications options, peripherals, software packages, and development tools, all based on industry standards.

The System 301/302 however, are based on the PC Bus architecture and allow the OEM to rapidly access Intel's microprocessor technology in a platform system ideal for CAD/CAM and other applications (see page 121.) These systems are based on Intel's 386AT Motherboard. Intel is committed to delivering these boards and systems with the highest performing microprocessors concurrent with microprocessor availability to facilitate the OEM's time to market. All our systems are backed by the companies extensive service and support operation.

SERIES 300 FAMILY OF MICROCOMPUTER SYSTEMS

Intel's Series 300 systems are based on the world standard high performance 86-family of Intel microprocessors and the MULTIBUS (IEEE 796) architectures. Each system is designed according to many industry standards, while taking advantage of the latest in processor technology. Each of the systems is available with several operating system and expansion options. The Series 300 family consists of the 310AP and 320 multiuser systems, each featuring a broad range of expansion, price, and performance options.

System 310AP — Built on an 8 MHz 80286 microprocessor, supporting up to sixteen users and available with an enhanced mass storage subsystem and including three integrated peripherals—floppy and Winchester disk drives and streaming cartridge tape—the System 310AP also features a variety of communications options and supports both the iRMX and XENIX operating systems.

System 320 — Based on the 80386, which delivers 3–4 MIPS and provides the user with the performance and capabilities of a minicomputer at less than half the cost, the 320 can be customized to meet the user's application requirements. The System 320 is available in a MultiSERVER™ configuration for office applications, a Financial Configuration for transaction processing applications, and the base system, which is configured by the customer specifically for his application. The System 320 is the first Intel system designed with factory-integrated flexibility.

The system options, include additional memory, communication options, networking, tape, hard disks, and floppy drives. The base system ships with five expansion slots and three full-height 5¼″ peripheral bays. The 320 runs either iRMX or XENIX operating systems. The system is shipped pre-configured to the customers specifications and is supported by the Intel Service Operation.

SYSTEM 320 — Solving the Computational and Communications Needs of the Financial Market

In the financial market, seconds are worth millions. Intel's real-time systems provide our customer the ability to respond immediately to real world events.

Intel's iRMX-based systems, when used as trader workstations, provide the user the ability to respond instantaneously to changing market conditions or new information. Designed to manage and extend the resources of Intel systems, this multitasking operating system provides configurable resources, ranging from interrupt management and standard device drivers to data file management commands for human interface and program development. A wide range of popular industry-standard languages is also available.

The user has several options for communications. Intel systems support OpenNET, Intel's networking architecture, which adheres to the International Standards Organization (ISO) Open Systems Interconnect (OSI) model. The System 320 also communicates with host computers utilizing X.25 and SNA and protocols. This communication capability allows users to have real-time access to a host computer through the System 320, off-loading the mainframe and making more effective use of mainframe processing.

The real-time system 320 features:

- High performance trade distribution
- 80386-based system
- iRMX real-time, multitasking operating system
- OpenNET local area networking
- Host communication to mainframes
- Complete installation, service and support
- Range of configuration

Intel Financial System 320 is used by prominent stock exchanges, brokerage firms, and investment banks. In a world where seconds cost millions, Intel systems have proven to be a good investment.

80386-BASED AT MOTHERBOARD

The Intel SBC386AT is the new 80386-based "motherboard" for OEMs designing advanced 32-bit computing systems. The board is form, fit and function compatible with the PC AT. Additional features include on-board serial and parallel ports, two 32-bit memory expansion slots, and a socket which supports the 80387 math coprocessor or the 80287 math coprocessor on an expansion module.

A system designed using the SBC386AT emulates the PC AT, but replaces the 16-bit data paths of the AT with 32-bit data handling for both memory and math interfaces. It also provides access to the full capabilities of the 80386's protected mode architecture. With the ability to address up to 16 MB of memory, it is an excellent platform for UNIX applications. The complete SBC386AT board set includes the systems baseboard, 32-bit memory expan-

sion boards available in densities of 2 and 8 MB, and a coprocessor expansion module with a 10 MHz 80287. It provides the capability to bring a high quality 32-bit DOS-compatible system to market quickly with a minimum of technical risk.

SYP301/302 SYSTEMS

The SYP301 and SYP302 are systems-level implementations of the SBC386AT motherboard described above. It offers the power of the 80386 microprocessor with the flexibility of the PC AT based architecture. This combination produces an OEM system well suited to high performance applications such as computer aided design, computer aided engineering, and advanced financial analysis which require greater processing and memory capability as well as PC compatibility. With eight PC card slots, the system can be customized easily by OEMs using off-the-shelf boards, operating systems and application software.

OEM SOFTWARE

Intel offers a broad range of OEM operating systems and languages. For real-time, embedded and commercial applications, the iRMX Operating System family is the OEM software offering. The iRMX-86 Operating System is the entry-level family member supporting a broad range of Intel processors, making it the current world standard for 16-bit applications requiring fast response times to real-time events. The newest family member, the iRMX-286 Operating System, is the evolving flagship 16-bit iRMX family member for the late 1980s.

Intel also supports XENIX 286 R3.5, a fully licensed version of UNIX tuned especially for Intel's Series 300 Systems and other microcomputers. XENIX is well suited to development and business applications. In addition, Intel provides a set of high-level languages and applications packages for the XENIX operating system. Many of these packages are sold by Intel to provide single stop shopping for system customers. Also, Intel's microprocessor and microcontroller are supported by a set of high-level languages: PL/M, C, Pascal and FORTRAN and assemblers (refer to the Development Tools section).

MICROCOMMUNICATIONS SYSTEMS

INTEL'S MICROCOMMUNICATIONS SYSTEM SOLUTIONS

Intel's broad spectrum of system-level microcommunications solutions include:

- OpenNET Family of Networking Building Blocks
- FASTPATH™ for Mainframe Connectivity
- MultiSERVER File and other Network Services
- BITBUS Microcontroller Interconnect
- Network Installation Services

The remainder of this section discusses each of Intel's system Microcommunication product offerings. For more in-depth technical information refer to the Microcommunication Handbook for data sheets, article reprints, application notes and other technical information.

OpenNET™ PRODUCT FAMILY

Intel's OpenNET product family includes a broad spectrum of Local Area Network building blocks, including communications modules, OpenNET software products and systems level network servers. The OpenNET product family is available to support all seven layers of the Open Systems Interconnection (ISO) model.

OpenNET™ Software

The OpenNET software products which include iRMX-NET Networking Software, XENIX-NET Networking Software, VMS-NET, and the iNA 960 Transport and Network Layer Software are based on industry standard networking protocols and provide transparent remote file access interoperation between XENIX, iRMX, VAX/VMS, and PC-DOS or MS-DOS systems.

OpenNET MAPNET™ Communication Software, along with iNA 960 Transport and Network Layer Software, is available in configurable and pre-configured versions to provide an ISO-OSI layers 3-7 implementation of the MAP (Manufacturing Automation Protocols) specification. This software, executing on an Intel iSBC 554 board, provides a complete seven-layer MAP solution.

Complete seven-layer Ethernet solutions are available in various configurable and pre-configured versions for XENIX and iRMX environments as well. These include either of the iSBC or iSXM™ 552 Ethernet Communication Engines or the iSBC 186/51 Communications Computer, in conjunction with the iNA 960 or iNA 961 Transport and Network Layer Software and the iRMX-NET or XENIX-NET Networking Software.

Users of IBM PC AT, PC XT and compatible computers can access Intel's OpenNET networking system, using Microsoft's MS-NET, through the OpenNET Personal Computer Link2 (PC Link2). An 80186/82586 microprocessor-based expansion board, PC Link2 is easily installed in a PC expansion card slot and uses only 44K of PC memory. The software package incorporates the MS-NET and iNA 960 (ISO 8073 compatible) transport software.

OpenNET PC Link2 gives the freedom to network PCs in the most advantageous way possible, whether as consumer workstations or as file servers. PC Link2 also allows easy access to files on other operating systems, such as iNDX, XENIX, iRMX, or VAX/VMS.

Intel's iNA 960 and its derivative iNA 961 implement the industry standard ISO 8073 transport protocols and ISO 8473 network protocols. These provide reliable end-to-end message delivery between two networked systems on an IEEE 802.3/Ethernet or an IEEE 802.4 Token Bus LAN. iNA 960/961 is fully supported by Intel's IEEE 802.3 and IEEE 802.4 LAN hardware modules.

The iRMX-NET and XENIX-NET products are based on the Network File Access protocols developed by IBM, Microsoft, and Intel and provide transparent remote file access between XENIX, iRMX, VAX/VMS, and PC- or MS-DOS based systems. Transparent remote file access enables the user to work with remote files across the local area network as if they were local. iRMX-NET and XENIX-NET are supported by iNA 960/961 and Intel's LAN hardware modules. This set of products runs in an IEEE 802.3 environment.

MAPNET Communications Software includes FTAM, CASE, SESSION, and Network Management/Directory Services and runs in an IEEE 802.3 or 802.4 environment.

Additional features and capabilities can be added to an OpenNET environment with the addition of Intel's MultiSERVER system enhancement.

Intel's VAX/VMS-NET Networking Software allows you to connect a VAX or MicroVAX II system to other OpenNET systems. This includes the IBM PC AT, PC XT, Intel's OpenNET Network Resource Manager (NRM), NDS II Network Development System), iRMX and XENIX systems. VMS-NET enables a (Micro) VAX to be configured as a server system on the OpenNET network, thus allowing any OpenNET consumer workstation (iRMX, XENIX, MS-DOS) to transparently access files residing at remote (Micro) VAX systems. In addition, VMS-NET supports bidirectional file transfer initiated from a (Micro) VAX to all other OpenNET servers.

Furthermore, Intel's VAX/VMS-NET networking software links and OpenNET networks link tools hosted on Intel development systems with tools hosted on other industry-standard systems. This permits the host workstation to be an integral part of a complete development network using Intel's NDS-II and OpenNET/Ethernet networks, Intel's implementation of the high-performance IEEE 802.3 Ethernet Local Area Network.

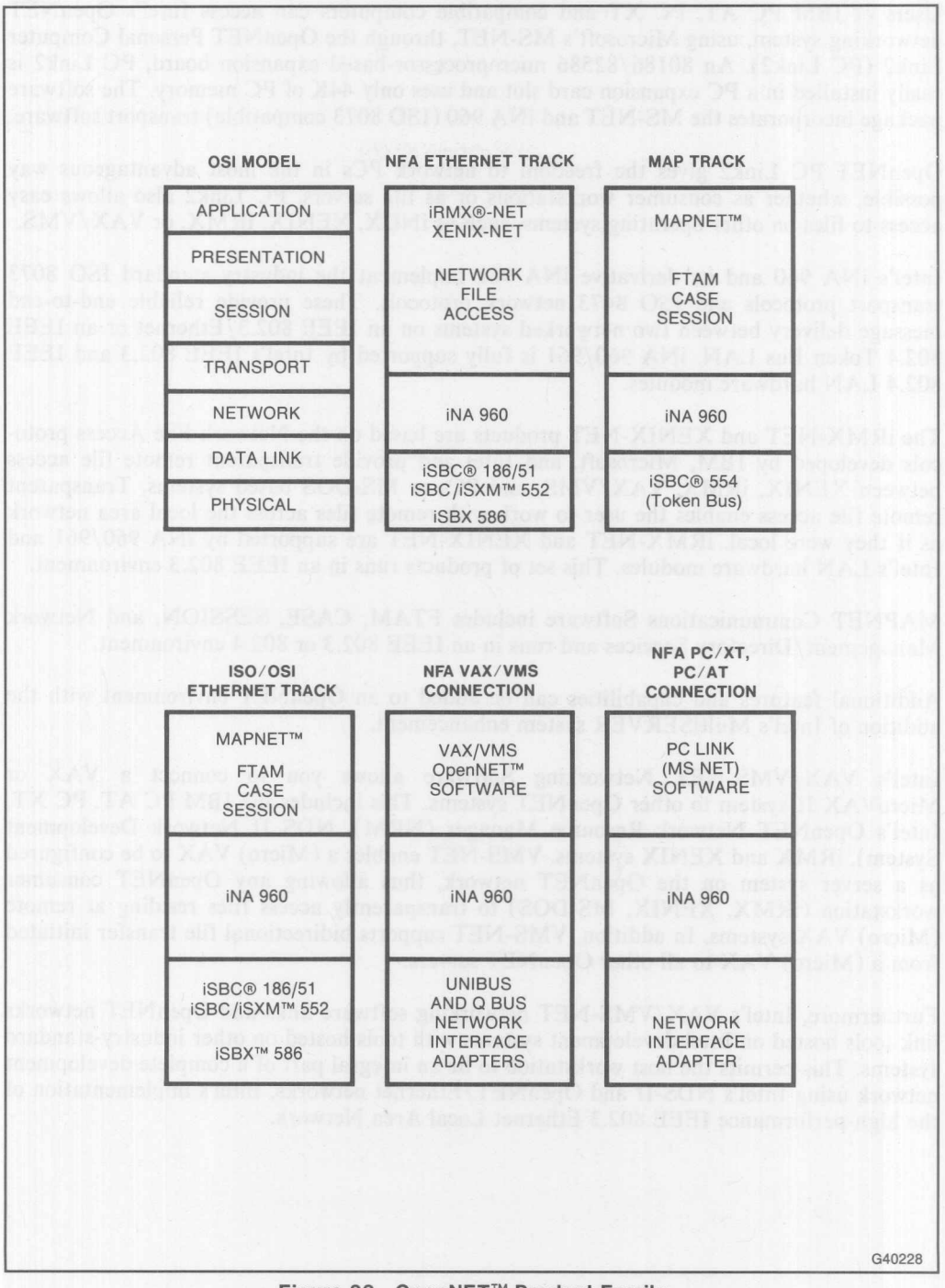


Figure 33. OpenNET™ Product Family

OpenNET™ Family of Local Area Network Products

Intel's LAN system building blocks are all part of the OpenNET product family. These modules allow the user to implement networks based on Ethernet (IEEE 802.3) and Token Bus (IEEE 802.4) that have transparent interoperability between multiple operating systems. The OpenNET modules listed in Table 62 cover layers 1 through 4 of the OSI reference model. Used together with Intel's iRMX and XENIX Networking Software or the MAPNET Communications Software, the user can implement a complete seven-layer solution for MULTIBUS systems. The OpenNET product line provides quick-time-to-market networking solutions and LAN communications with IBM PCs and VAX/VMS systems.

Table 62. OpenNET™ LAN Products

Product	Description
iSBC 186/51 COMMputer™	• Integrates processing and communications capabilities onto a single board. • Ethernet (IEEE 802.3) and two serial (RS-232/RS-422/RS-449) connections supported. • Designed around the 80186 microprocessor and the 82586 LAN Coprocessors. • Two iSBX bus connectors for low-cost expansion.
iSBC 552A IEEE 802.3 Ethernet COMMengine and iSXM 552A IEEE 802.3 Ethernet Transport Engine	• Dedicated Ethernet (IEEE 802.3) LAN Communications Engine. • Based on the 80186 microprocessor and the 82586 LAN Coprocessor. • Supports iNA 960 ISO Transport/Internetwork software. • Can be used with multiple operating systems. • iSXM 552A is a preconfigured version providing a turnkey solution for ISO layers 1-4.
iSBX 186/530 MULTIBUS II IEEE 802.3/ Ethernet COMMengine	• Dedicated Ethernet (IEEE 802.3) LAN Communications Engine. • MULTIBUS II iPSC® (Parallel System Bus) Interface with full message passing capability. • Based on the 80186 Embedded Controller and the 82586 LAN Coprocessor. • Supports iNA 960 ISO Transport/Internetwork Software.
iSBX 586 Ethernet Data Link Engine	• Low-cost solution for Ethernet (IEEE 802.3) connections. • Single wide iSBX MULTIMODULE for use with MULTIBUS boards with 16-bit iSBX capabilities. • Takes advantage of the high performance 82586 LAN Coprocessor. • 16KB on-board buffer memory.
Intellink™ (DCM 911)	• Connects up to nine Ethernet-compatible end nodes without the need for transceivers and coaxial cable. • Can be connected directly to an Ethernet cable through a standard transceiver and transceiver cable.

Table 62. OpenNET™ LAN Products (Cont'd.)

Product	Description
iSBC 554 MAP COMMengine	• Front End Communications Engine that supports a complete seven-layer MAP solution. • 10Mbps IEEE 802.4 Broadband Token Bus Interface • Supports preconfigured iNA961 ISO Transport/ Internetwork Software. • Intel's MAP Software for layers 5 through 7 can be run on-board.
iNA 960 Transport/Network Software iRMX-NET XENIX-NET MAPNET VMS-NET	• Supports both Ethernet (IEEE 802.3) and MAP (IEEE 802.4) protocols. • Conforms to MAP 2.1 specification ISO Transport (8073) and Network (8473) standards. • Provides reliable "virtual circuit" process-to-process message delivery service. • Runs on 8086 and 80186 systems with the 82586 LAN Coprocessor.
OpenNET PC Link2	• Runs on IBM PC AT, PC XT, and PC-DOS compatibles • Uses standard DOS commands. • Interconnects to iRMX, XENIX, and VAX/VMS NDS-II NRM Systems having OpenNET server capability. • Uses ISO 8073 transport and Ethernet/IEEE 802.3 standard communication protocols. • Intelligent high-performance hardware with on-board microprocessor, 16K bytes EPROM and 256K bytes RAM.

Point-to-Point Communications

Intel also provides the building blocks for point-to-point communications. These products can be used in terminal cluster control, modem control, host communications, or general purpose applications. The product family supports a variety of communication electrical interfaces and protocols to allow open systems flexibility.

Table 63. Point-to-Point Communication Modules

Product	Description
iSBC 188/56 COMMputer	• Intelligent eight-channel single-board system. • 8 MHz 80188 and 256K bytes DRAM. • Expandable to twelve channels via 2 iSBX 354. • Supports ASYNC/SYNC, SDLC/HDLC. • Supports RS232C on six to eight channels, RS422 on up to two channels.
iSBC 88/45 ADCP (Data Communications Processor)	• Intelligent communications controller can function as single board multimaster CPU or slave datacomm gateway. • 8 MHz 8088/10 (8088-2) microprocessor. • Three half/full duplex communication channels support HDLC/SDLC/ASYNCH/SYNCH operation. • Two iSBX bus connectors to expand to five communication channels with iSBX 351 serial expansion MULTIMODULE boards.
iSBC 548 High-Performance Terminal Controller	• 8 RS232C channels. • 8 MHz 80186 and 128K bytes DRAM. • On-board terminal handler firmware. • Full iRMX and XENIX Support.
iSBC 554 Intelligent Communications Controller	• Acts as a single-board communications controller or an intelligent slave for multi-terminal communications expansion. • On-board dedicated 8085A CPU provides communications control and buffer management for four programmable synchronous/asynchronous channels. • Ten programmable parallel I/O wires compatible with Bell 801 Automatic Calling Unit (ACU).
iSBC 534 Four-Channel Communications Board	• Four fully programmable synchronous and asynchronous serial communications channels. • 16-bit parallel I/O interface compatible with the Bell 801 Automatic Calling Unit (ACU).

SYSTEM 320—MultiSERVER™ SYSTEMS FOR THE OFFICE

As the personal computer or computer workstation has proliferated, so has the requirement for users to communicate, share data, and access other computers. Enter MultiSERVER Systems, allowing personal computers, terminals, and mainframes to communicate. Intel now provides turnkey solutions to meet today's department networking needs.

High Performance MultiSERVER™ Systems

MultiSERVER Product is a complete networking solution that provides the user with the ability to automate entire departments, connecting PCs, terminals, and mini- and mainframe computers. And because our MultiSERVER product is based on the Series 300 microcomputer, you can run software packages on the server, with the PC acting as a terminal, or on the PC, depending on your application.

MultiSERVER Systems deliver to "work groups" and individuals a comprehensive, fully integrated set of services which extend the computing and information resources of entire departments.

MultiSERVER Systems features include:

- High-performance 80386-based system
- Complete department service network, including:
  - — File services
  - — Print services
  - — Communications services
  - — Network application services
  - — Administrative services
  - — Computing services
- Complete installation, service, and support
- Range of configuration

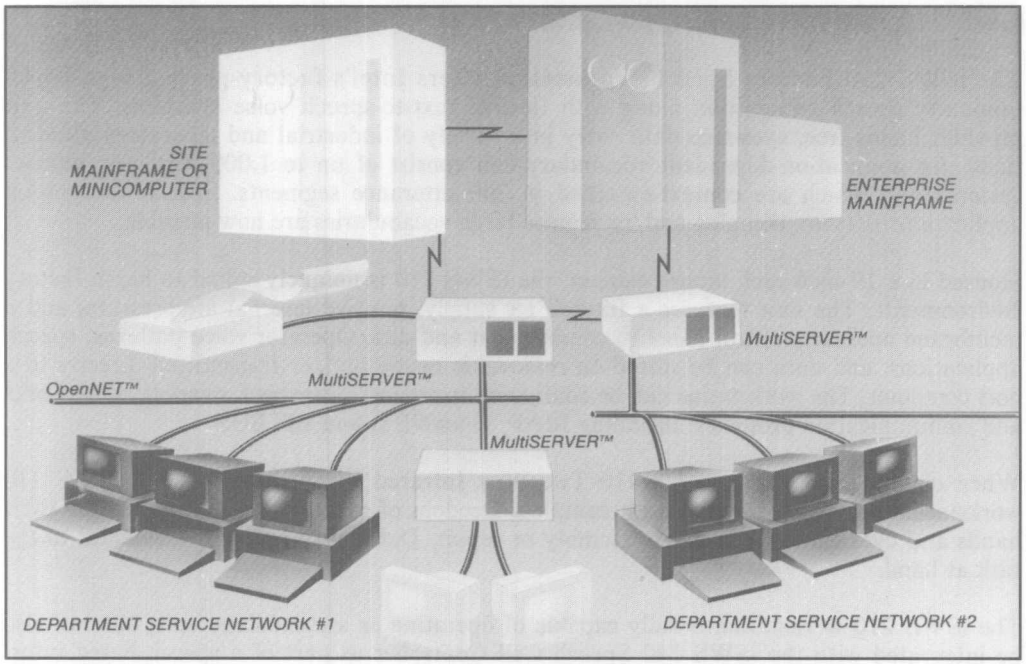


Figure 34. MultiSERVER™ System 320

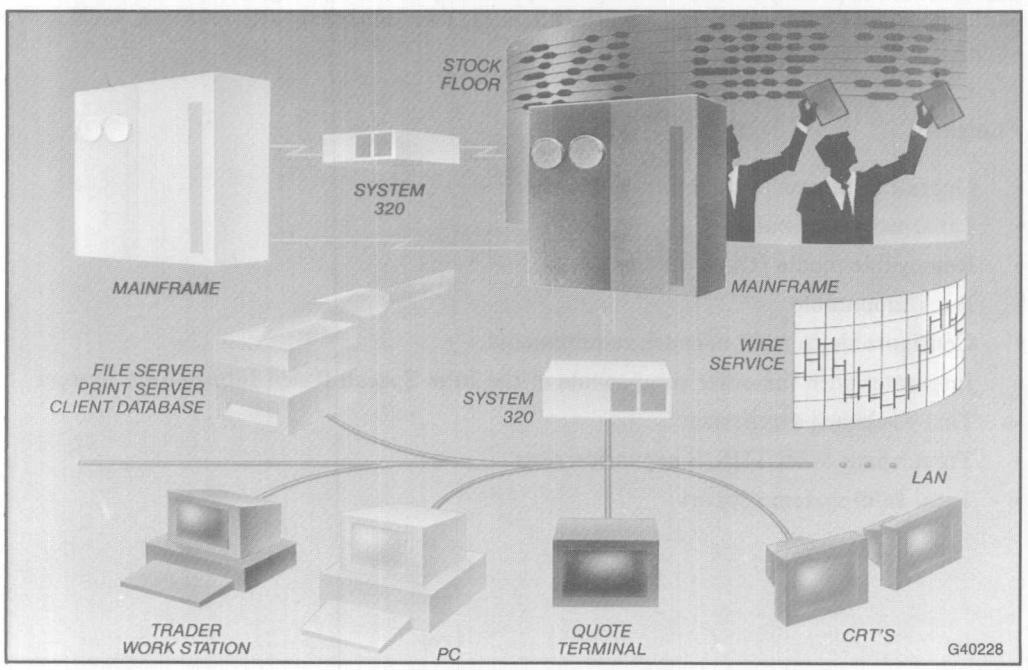


Figure 35. Financial System 320

iSWS 210 FACTORY SPEECH WORKSTATION

The iSWS 210 Factory Speech Workstation offers Intel's factory-proven, high-noise-immunity speech recognition along with flexible text-to-speech voice synthesis. The unit provides hands-free, eyes-free data entry in a variety of industrial and laboratory applications. An application-dependent vocabulary can consist of up to 1,000 words or phrases (utterances), which are context-switched in 200 utterance segments. Speech recognition applications that are complex and/or require large vocabularies are now possible.

Housed in a 19-inch rack mount cabinet, the iSWS 210 is uniquely suited to harsh factory environments. The unit features a filtered air supply, positive internal air pressure, and a membrane operator control panel to combat dust and dirt. Operator voice patterns, speech applications, and data can be stored on removable media and/or transmitted directly to a host computer. The workstation can be configured to communicate over a variety of networks and communication protocols, including MAP, OpenNET, and BITBUS.

When combined with the iSWS 410 Two-Way Infrared Wireless option, the iSWS 210 workstation provides operators with complete freedom of mobility, as well as freeing their hands and eyes for tasks such as assembly or repair. Data entry becomes incidental to the task at hand.

The iSWS 210 workstation is fully capable of operating as a standalone unit, but can also be integrated with the iSWS 540 Speech Cell Controller as part of a speech-based information system. Intel also offers the iSWS 210 workstation in complete turnkey solutions. This includes application analysis and development, operator training, and installation. Intel's worldwide sales and service network provides the total support required in factory automation.

Features

- Operates in harsh factory environments
- 1,000-word vocabulary
- Removable media (three options)
- Rack mountable
- Configurable to most network requirements
- Integrates with the other components of the Intel Speech Based Information System
- Text-to-speech synthesizer
- Three spare MULTIBUS expansion slots
- Total Intel system support

MAINFRAME CONNECTIONS

FASTPATH™ INTERCONNECT

The FASTPATH 9750 is a family of powerful control units that directly connects IBM System/370's or compatibles in a peer-to-peer relationship with applications and allows you to move mainframe processing resources closer to end-users. By attaching to the System/370 I/O channel, the 9750 control unit bypasses the bandwidth and architectural limitations of the front-end processor and accommodates data movement for a wide range of applications.

FASTPATH is a Channel-to-MULTIBUS Adapter connecting the Intel MULTIBUS architecture to an IBM System 370 I/O channel and other processors conforming to the 370 I/O specifications.

Complete software offerings are available with the FASTPATH 9750 control unit. These packaged offerings are easy to install, operate and maintain.

FASTPATH™ Features

The 9750 operates as a multidevice control unit on a block multiplexer channel. It supports 3 Megabytes per second data streaming through the block multiplexer channel and implements dynamic speed matching buffer for efficient channel utilization. The 9750 control unit supports up to 6 IEEE 796 MULTIBUS compatible application adapter boards, implements a remote maintenance facility and has worldwide service, support and training.

Depending on the level of function required, the FASTPATH mainframe connectivity product family is available to Original Equipment Manufacturers (OEMs), Value Added Resellers (VARs) and end-user data processing centers.

FASTPATH™ Applications

The 9750 control unit provides a high-throughput bridge between System/370 and non-System/370 processors, local and wide area networks and special peripherals. All of these applications are built from a common 9750 platform.

The 9750 is available as a complete, turnkey control unit for DP centers to connect System/370's and compatible mainframes to:

- DEC VAX minicomputers and DECnet.
- IEEE 802.4 broadband networks implementing the Manufacturing Automation Protocol (MAP).

- IEEE 802.3 Ethernet networks implementing custom access methods or standard protocols such as the Transmission Control Protocol/Internet Protocol (TCP/IP) and the Technical Office Protocol (TOP).
- Up to 256 asynchronous devices such as terminals, printers and modems. Software driver support is available for mainframe for the mainframe UNIX and MUMPS/VM environments.

Each application environment is associated with a particular FASTPATH family member and is designated by a specific model number. Each 9750 supports multiple pathways between a single System/370 class mainframe and the specific application environment. Additional pathways can be ordered either as configuration options or as field-installed upgrades.

Table 64. 9750 Family of Control Units

Model	Function	No. of Pathways Supported	Applicable to Customer Type
9750D	System/370-DR11W/DRB32W (DEC VAX)	4	DP Centers, OEMs and VARs
9750M	System/370-802.4 OSI MAP Network	4	DP Centers, OEMs and VARs
9750E	System/370-802.3 Ethernet Network	6	DP Centers, OEMs and VARs
9750S	System/370-ASCII Devices	256	DP Centers, OEMs and VARs

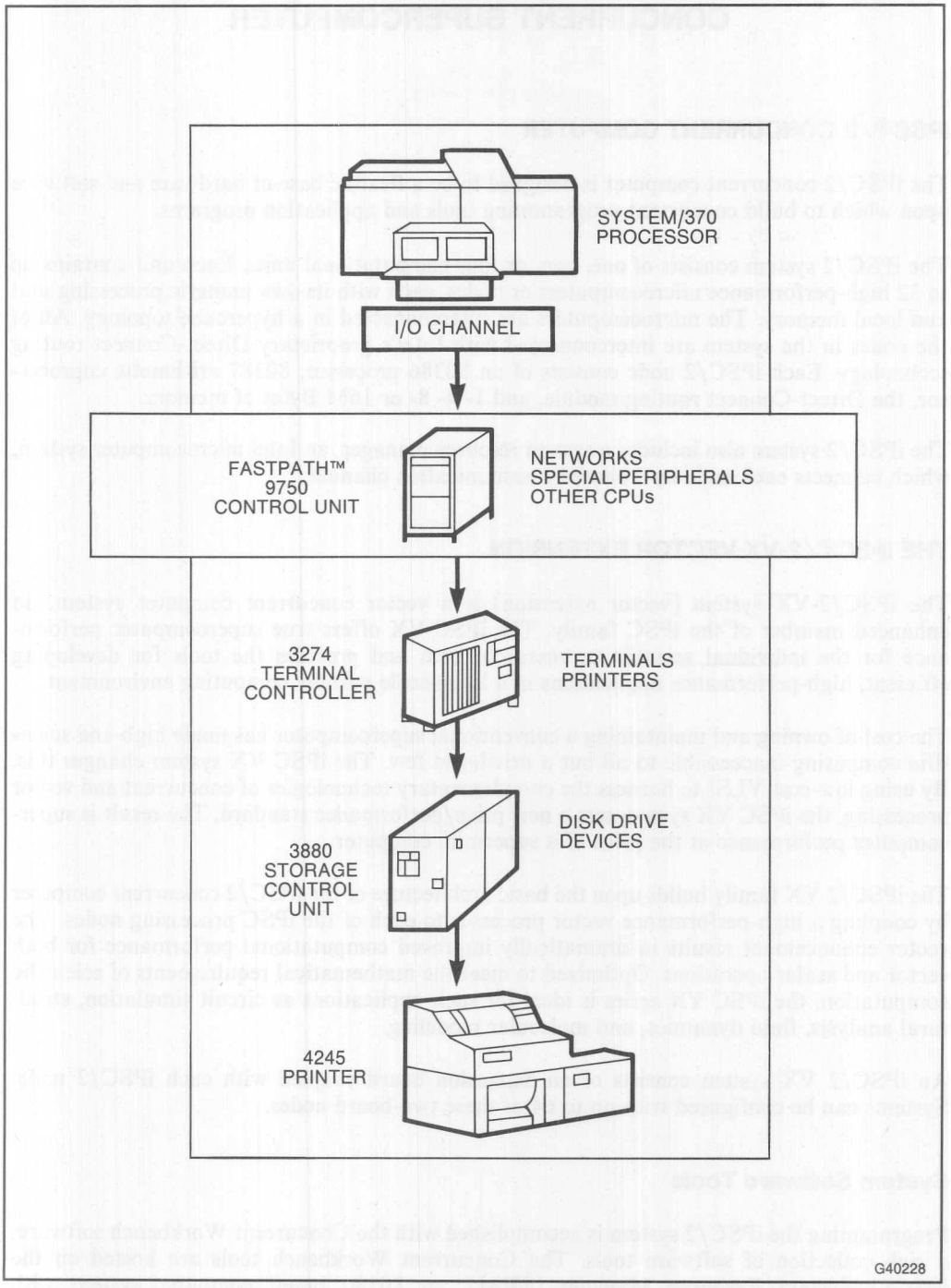


Figure 36. The FASTPATH™ Control Unit Attaches to the I/O Block Multiplexer Channel

CONCURRENT SUPERCOMPUTER

iPSC®/2 CONCURRENT COMPUTER

The iPSC/2 concurrent computer is designed to be a flexible base of hardware and software upon which to build concurrent programming tools and application programs.

The iPSC/2 system consists of one, two, or four computational units. Each unit contains up to 32 high-performance microcomputers or nodes, each with its own numeric processing unit and local memory. The microcomputers are interconnected in a hypercube topology. All of the nodes in the system are interconnected with Intel's proprietary Direct-Connect routing technology. Each iPSC/2 node consists of an 80386 processor, 80387 arithmetic coprocessor, the Direct-Connect routing module, and 1- 4- 8- or 16M Bytes of memory.

The iPSC/2 system also includes a system resource manager, an Intel microcomputer system, which connects each node by a shared communication channel.

THE iPSC®/2-VX VECTOR EXTENSION

The iPSC/2-VX system (vector extension) is a vector concurrent computer system, an enhanced member of the iPSC family. The iPSC-VX offers true supercomputer performance for the individual scientist or research team and provides the tools for developing efficient, high-performance applications in a large-scale parallel computing environment.

The cost of owning and maintaining a conventional supercomputer has made high-end scientific computing inaccessible to all but a privileged few. The iPSC VX system changes this. By using low-cost VLSI to harness the complementary technologies of concurrent and vector processing, the iPSC VX system sets a new price/performance standard. The result is supercomputer performance at the price of a supermini computer.

The iPSC/2 VX family builds upon the basic architecture of the iPSC/2 concurrent computer by coupling a high-performance vector processor to each of the iPSC processing nodes. The vector enhancement results in dramatically improved computational performance for both vector and scalar operations. Optimized to meet the mathematical requirements of scientific computation, the iPSC VX series is ideal for such applications as circuit simulation, structural analysis, fluid dynamics, and molecular modeling.

An iPSC/2 VX system consists of an expansion board coupled with each iPSC/2 node. Systems can be configured with up to 64 of these two-board nodes.

System Software Tools

Programming the iPSC/2 system is accomplished with the Concurrent Workbench software, a rich collection of software tools. The Concurrent Workbench tools are hosted on the iPSC/2 System Resource Manager (SRM), an 80386 based computer system with

8M bytes of memory and AT&T's UNIX operating system (Version V, release 3). The Concurrent Workbench software includes C, Fortran, and Concurrent Common LISP compilers, the VAST-2 vectorizer, and the DECON Concurrent Debugger. Also, the Concurrent Workbench can be accessed from remote workstations such as the Sun/3 workstation.

DECON is a symbolic debugger that supports simultaneous process-level and communications-level debugging on all nodes of the cube, as well as traditional process debugging on each node.

For iPSC-VX applications, VAST-2, a supercomputer-class FORTRAN vectorizer, is used for automatically vectorizing FORTRAN application code and translating the application code into an executable form for the vector processor.

Table 65. iPSC/2 Specifications

iPSC/2 Model	d3	d4	d5	d6	d7
Number of Nodes	8	16	32	64	128
Aggregate Performance (MIPS) All systems	32	64	128	256	512
Aggregate Performance (MFLOPS, 64-bit precision)					
Basic System	—	3.4	6.7	13	27
SC scalar extension	—	10	20	40	81
VX vector extension	53	106	212	424	—
Aggregate Memory					
Basic system and SX extensions					
Minimum (1M Byte per node*)	—	16	32	64	128
Maximum (16M Byte per node*)	—	256	512	1024	—
VX extension					
Minimum (1M byte per node**)	16	32	64	128	—
Maximum (8M byte per node**)	72	144	288	576	—

*Basic and SX systems also are available in configurations of 4 and 8M Bytes of memory per node.
**Figure includes memory per iPSC/2 node board plus 1M Byte on each vector extension board. VX systems are also available in configurations with 4M Bytes of memory per node.

Table 66. System Feature Specifications

System Feature	Specifications
Central Processor (CPU)	Intel 80386, native mode execution
Numeric Processor (NPU)	Intel 80387 (10 MHz) 32-, 64-, 80-bit floating point (IEEE 754) 32-, 64-bit integer 16-digit BCD operands
Memory	1, 4, 8, 16M byte modules
Communication	Direct connect routing implements a fully connected network. Variable length messages.
iLBX II Port	Bus bandwidth: 8M bytes/sec max. Even numbered slots are masters; odd are slaves
Indicators	Red and green LEDs (OS and user programmable) Amber LED (arithmetic indicators)
Size	2 × 4 Eurocard (9.2″ by 11″)

Table 67. Vector Processor (VP) Board

Arithmetic Unit	ALU: 100 nsec cycle time, pipelined operation 32-bit/64-bit floating point (ADD,SUB) 32-bit integer (ADD,SUB,AND,OR,XOR) Multiplier: 100 nsec (32-bit) cycle time or 300 nsec (64-bit) cycle time, pipelined operation 32-bit/64-bit floating point MULTIPLY
Program Memory	128K bytes (16K × 64), 100 nsec static RAM Supports VccLib function library and runtime monitor
Data Memory	1.0M bytes (256K × 32), 100 nsec cycle time dynamic RAM Dual ported, can be directly addressed by the VP's dedicated 32-bit Address ALU, or through the iLBX II bus by the 80386 node CPU (on a cycle stealing basis). Used as a shared data workspace for the node CPU and vector processor. Also available to the node CPU for user application code.
Fast Data Memory	16K bytes (4K × 32), 100 nsec cycle time static RAM Dual ported, can be directly addressed by the VP's dedicated 32-bit Address ALU, or through the iLBX II bus by the 80286 node CPU (on a cycle stealing basis). Used as high-speed data storage for table functions and intermediate computational results. 4K bytes are reserved for a user scratch pad.
Data Types	IEEE 754 floating-point (except gradual underflow) Single precision real: 32-bit Double precision real: 64-bit Single precision complex: 2*32-bit Double precision complex: 2*64-bit

Table 68. System Resource Manager Features

Central Processor (CPU)	80386
Numeric Processing Unit	80387 arithmetic
Memory	4.5M byte iLBX memory
Mass Storage	144M byte 5¼″ Winchester disk; 1.6M byte 5¼″ floppy; 60M byte ¼″ cartridge tape
Operating System	UNIX V.3

Table 69. Physical Specifications

	32-Node Unit	System Resource Manager
Height	49″	6.5″
Width	16″	21.3″
Depth	16″	17.3″
Weight	200 lbs	44 lbs
Footprint	26.75″ × 26.75″	21.3″ × 17.5″

Table 70. Electrical and Environmental Specifications

	Each 32-Node Unit	System Resource Manager
Electrical		
AC Voltage	230 VAC ± 15%	115/230 VAC ± 10%
AC Current	13.6 amps	.5 to 11 amps
Frequency	50/60 Hz ± 5%	50/60 Hz
Power	2704 watts	220 watts
Safety/RFI/EMI	UL 478	UL 478
(designed to meet)	CSA C22.2 No. 154	CSA C22.2 No. 154
	VDE 0606	VDE 0806
	VDE 0871	VDE 0871
	IEC 380	IEC 435
	FCC 47 CFRJ Class A	FCC CFR Part 1.5 Subpart J Class B
Environmental		
Operating Temp.	10-35°C	15.6 to 32.2°C
Humidity	85%, max. non-condensing	85%, max. non-condensing
Attitude	0–10,000 ft	0–7000 ft

iPSC® USER TRAINING

Training for one customer staff member is included with the purchase of each iPSC system. This three-day course titled "Programming Concurrent Computers" provides students with the fundamental knowledge, strategies, skills, and tools needed to design and implement large-scale concurrent software for the iPSC system.

SOFTWARE SUPPORT

Intel provides hardware and software support during the warranty period and under software support contracts after the warranty. For further details contact Intel Scientific Computers.

ORDERING INFORMATION

For more information on the Intel iPSC/2 concurrent computer family, contact:

Intel Scientific Computers
15201 N.W. Greenbrier Parkway
Beaverton, Oregon 97006
(503) 629-7629

DOMESTIC SALES OFFICES

ALABAMA

†Intel Corp.
5015 Bradford Dr., #2
Huntsville 35805
Tel: (205) 830-4010

ARIZONA

†Intel Corp.
11225 N. 28th Dr., #D214
Phoenix 85029
Tel: (602) 869-4980

Intel Corp.
1161 N. El Dorado Place
Suite 301
Tucson 85715
Tel: (602) 299-6815

CALIFORNIA

†Intel Corp.
21515 Vanowen Street
Suite 116
Canoga Park 91303
Tel: (818) 704-8500

†Intel Corp.
2250 E. Imperial Highway
Suite 218
El Segundo 90245
Tel: (213) 640-6040

Intel Corp.
1510 Arden Way, Suite 101
Sacramento 95815
Tel: (916) 920-8096

†Intel Corp.
4350 Executive Drive
Suite 105
San Diego 92121
Tel: (619) 452-5880

Intel Corp.*
400 N. Tustin Avenue
Suite 450
Santa Ana 92705
Tel: (714) 835-9642
TWX: 910-595-1114

†Intel Corp.*
San Tomas 4
2700 San Tomas Expressway
Santa Clara, CA 95051
Tel: (408) 986-8086
TWX: 910-338-0255

COLORADO

Intel Corp.
4445 Northpark Drive
Suite 100
Colorado Springs 80907
Tel: (303) 594-6622

†Intel Corp.*
650 S. Cherry St., Suite 915
Denver 80222
Tel: (303) 321-8086
TWX: 910-931-2289

CONNECTICUT

†Intel Corp.
26 Mill Plain Road
Danbury 06811
Tel: (203) 748-3130
TWX: 710-456-1199

FLORIDA

†Intel Corp.
242 N. Westmonte Dr.
Suite 105
Altamonte Springs 32714
Tel: (305) 869-5588
FAX: 305-682-6047

Intel Corp.
6363 N.W. 6th Way, Suite 100
Ft. Lauderdale 33309
Tel: (305) 771-0600
TWX: 510-956-9407
FAX: 305-772-8193

Intel Corp.
11300 4th Street North
Suite 170
St. Petersburg 33702
Tel: (813) 577-2413
FAX: 813-578-1607

GEORGIA

†Intel Corp.
3280 Pointe Parkway
Suite 200
Norcross 30092
Tel: (404) 449-0541

ILLINOIS

Intel Corp.*
300 N. Martingale Road, Suite 400
Schaumburg 60173
Tel: (312) 310-8031

INDIANA

†Intel Corp.
8777 Purdue Road
Suite 125
Indianapolis 46268
Tel: (317) 875-0623

IOWA

Intel Corp.
St. Andrews Building
1930 St. Andrews Drive N.E.
Cedar Rapids 52402
Tel: (319) 393-5510

KANSAS

†Intel Corp.
8400 W. 110th Street
Suite 170
Overland Park 66210
Tel: (913) 345-2727

MARYLAND

Intel Corp.*
7321 Parkway Drive South
Suite C
Hanover 21076
Tel: (301) 796-7500
TWX: 710-862-1944

Intel Corp.
5th Floor
7833 Walker Drive
Greenbelt 20770
Tel: (301) 441-1020

MASSACHUSETTS

†Intel Corp.*
Westford Corp. Center
3 Carlisle Road
Westford 01886
Tel: (617) 692-3222
TWX: 710-343-6333

MICHIGAN

†Intel Corp.
7071 Orchard Lake Road
Suite 100
West Bloomfield 48033
Tel: (313) 851-8096

MINNESOTA

Intel Corp.
3500 W. 80th St., Suite 360
Bloomington 55431
Tel: (612) 835-6722
TWX: 910-576-2867

MISSOURI

Intel Corp.
4203 Earth City Expressway
Suite 131
Earth City 63045
Tel: (314) 291-1990

NEW JERSEY

Intel Corp.*
Parkway 109 Office Center
328 Newman Springs Road
Red Bank 07701
Tel: (201) 747-2233

Intel Corp.
280 Corporate Center
75 Livingston Avenue
First Floor
Roseland 07068
Tel: (201) 740-0111

NEW MEXICO

Intel Corp.
8500 Menual Boulevard N.E.
Suite B 295
Albuquerque 87112
Tel: (505) 292-8086

NEW YORK

Intel Corp.
127 Main Street
Binghamton 13905
Tel: (607) 773-0337

Intel Corp.*
850 Cross Keys Office Park
Fairport 14450
Tel: (716) 425-2750
TWX: 510-253-7391

Intel Corp.*
300 Motor Parkway
Hauppauge 11787
Tel: (516) 231-3300
TWX: 510-227-6236

Intel Corp.
Suite 2B Hollowbrook Park
15 Myers Corners Road
Wappinger Falls 12590
Tel: (914) 297-6161
TWX: 510-248-0060

NORTH CAROLINA

Intel Corp.
5700 Executive Center Drive
Suite 213
Charlotte 28212
Tel: (704) 568-8966

†Intel Corp.
2700 Wycliff Road
Suite 102
Raleigh 27607
Tel: (919) 781-8022

OHIO

Intel Corp.*
3401 Park Center Drive
Suite 220
Dayton 45414
Tel: (513) 890-5350
TWX: 810-450-2528

Intel Corp.*
25700 Science Park Dr., Suite 100
Beachwood 44122
Tel: (216) 464-2736
TWX: 810-427-9298

OKLAHOMA

Intel Corp.
6801 N. Broadway
Suite 115
Oklahoma City 73116
Tel: (405) 848-8086

OREGON

†Intel Corp.
15254 N.W. Greenbrier Parkway, Bldg. B
Beaverton 97006
Tel: (503) 645-8051
TWX: 910-467-8741

PENNSYLVANIA

Intel Corp.
1513 Cedar Cliff Drive
Camp Hill 17011
Tel: (717) 737-5035

Intel Corp.*
455 Pennsylvania Avenue
Fort Washington 19034
Tel: (215) 641-1000
TWX: 510-661-2077

Intel Corp.*
400 Penn Center Blvd., Suite 610
Pittsburgh 15235
Tel: (412) 823-4970

PUERTO RICO

Intel Microprocessor Corp.
South Industrial Park
P.O. Box 910
Las Piedras 00671
Tel: (809) 733-8616

TEXAS

†Intel Corp.
313 E. Anderson Lane
Suite 314
Austin 78752
Tel: (512) 454-3628

†Intel Corp.*
12300 Ford Road
Suite 380
Dallas 75234
Tel: (214) 241-8087
TWX: 910-860-5617

Intel Corp.*
7322 S.W. Freeway
Suite 1490
Houston 77074
Tel: (713) 988-8086
TWX: 910-881-2490

UTAH

Intel Corp.
5201 Green Street
Suite 290
Murray 84123
Tel: (801) 263-8051

VIRGINIA

†Intel Corp.
1504 Santa Rosa Road
Suite 108
Richmond 23288
Tel: (804) 282-5668

WASHINGTON

Intel Corp.
155-108 Avenue N.E.
Suite 386
Bellevue 98004
Tel: (206) 453-8086
TWX: 910-443-3002

Intel Corp.
408 N. Mullan Road
Suite 102
Spokane 99206
Tel: (509) 928-8086

WISCONSIN

†Intel Corp.
330 S. Executive Dr.
Suite 102
Brookfield 53005
Tel: (414) 784-8087
FAX: (414) 796-2115

CANADA

BRITISH COLUMBIA

Intel Semiconductor of Canada, Ltd.
4585 Canada Way, Suite 202
Burnaby V5G 4L6
Tel: (604) 298-0387
FAX: (604) 298-8234

ONTARIO

†Intel Semiconductor of Canada, Ltd.
2650 Queensview Drive
Suite 250
Ottawa K2B 8H6
Tel: (613) 829-9714
TLX: 053-4115

†Intel Semiconductor of Canada, Ltd.
190 Attwell Drive
Suite 500
Rexdale M9W 6H8
Tel: (416) 675-2105
TLX: 06983574
FAX: (416) 675-2438

QUEBEC

†Intel Semiconductor of Canada, Ltd.
620 St. Jean Boulevard
Pointe Claire H9R 3K3
Tel: (514) 694-9130
TWX: 514-694-9134

†Sales and Service Office
*Field Application Location